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PREFACE

Centre for Disaster Management (CDM), LBSNAA is a capacity building and research centre functioning under the umbrella of LBSNAA, Mussoorie. Apart from conducting training programmes the Centre has been involved in formulation of national strategy for adaptation of the global best practices to suit Indian conditions in the field of disaster management. Centre is key national institution to impart comprehensive training on disaster management with a special focus on the IRS. The impact of disasters have been increased drastically in terms of human, economic and environmental losses. Climate Change have greater contribution to the increasing frequency, intensity and unpredictability of disasters.

The sound implementation of disaster management laws and policies can play an important role in mitigating the negative effects of disasters and can contribute to the development of more resilient societies. Disasters disrupt progress and destroy the hard-earned fruits of painstaking development efforts, often pushing communities, in quest for progress, back by several decades. Thus, efficient management of disasters, rather than mere response to their occurrence has, in recent times, received increased attention, both within the country and abroad. In a caring and civilized society, it is essential to deal effectively with the devastating impact of disasters, looking at the increased frequency and intensity of disasters in recent times.

In continuation to the successful publication of the three issue of the journal Disaster-Response and Management" from Centre for Disaster Management, it is our pleasure to publish Volume 4, Issue 1 of the journal "Disaster-Response and Management" for the year 2015. The journal will provide an insight to administrators about the field level disaster management and scientific interventions towards Disaster Risk Reduction. I would like to place on record the contribution made by faculty and staff of CDM who have contributed in various capacities for bringing out this Journal.

C. Sridhar, IAS
Deputy Director (Sr.) & Director (CDM),
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CONTENTS

Public Health Response during Urban Floods: Learning from Chennai Floods 2015-16

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Abstract:

Background: *Weather related disasters especially urban floods are seen increased in last few decades. Trend is again predicted that there will be rise in number of people affected by floods in coming years. In the era of climate change storms will be more unpredicted, more intense and more frequent which will lead to severe urban flooding. Unplanned construction and overload of population in urban areas have been already increased the vulnerability. In such a scenario, dealing with public health is indeed a challenge for every country/state. As part of being prepared every country/ state has formulated their own Disaster Management Plan (DMP). Most of the components of disaster response initiatives will remain the same in different places. It is felt in some countries that the DMP's are more generic and lacks somewhere in providing actual road map of practices during responses.*

Objective: *To contribute the literature of flood response activities, this article makes an sincere attempt to compile the observations made during the disaster response, which can be considered in strengthening of Disaster Management Plans and policies.*

Methodology: *The documentation for this study was conducted as an external faction during the flood response in an area of Chennai metropolitan city of state Tamil Nadu (India) during Floods 2015-16. The documentation period was from 2nd December 2015 to the 17th January 2016 when the response was officially stopped.*

Conclusion: *Well-organized MMUs are competent means to conduct syndromic surveillance and planned MMU's helps to reach out larger population in shorter time to avoid outbreaks during post disaster scenario. The very nature of resource constrains settings in disasters these MMUs should be scientifically planned, based on proper analysis so that it is meticulously utilized. Planned mobilization of resources as external support and appropriate utilisation of existing resources plays important role to deal with the crisis situation. Having a monitoring officer (IAS-Cadre) as head of the operations at Zone-Ward level in metro cities during response, as a single hierarchy in decision making will help to hasten the response process by quick decisions and maintain coordination between various departments and resources. A humanitarian response expert with an orientation on public health aspects and other disaster response standards will be a good addition to the team. Such technical support will help to identify & address the specific needs post disaster, maintain coordination and ensure quality implementation of disaster response. The ground level information and activities performed during actual response*

mentioned in this article can be used in formulation of Disaster Management Plans to make it less generic and will assist to provide actual roadmap.

Keywords: *Urban Floods, Climate Change, Mobile Medical Units (MMUs), Disaster Management Plan (DMP), AS (Indian Administrative Services).*

Introduction:

A predicted trend about the rise in disasters in the 21st century has been experienced all over the world over the last decade, especially in the last few years. [1] There has been an increase in the frequency of weather related disasters in recent years which are largely due to a rise in the number of storms and floods. Among weather related disasters, the majority, 47%, were floods. Floods occurring from 1995 to 2015 affected 2.3 billion people, with 95% of the affected in Asia. The average number of flood cases per year increased from 127 in the period 1996-2004 to 171 in the period 2005-2014. [2]

Urban centres across the world are facing various environmental challenges, primarily in the form of floods. Flooding has become more intense and frequent in many regions as climate change continues to affect precipitation intensity, duration and frequency.[3] There is a need to enhance flood management strategies and response to reduce adverse impact of floods in the future and to build urban resilience.[4] A report published by Intergovernmental Panel on Climate Change (IPCC) says that there will be an increased number of people exposed, from 1.65 million in 1970 to 1.87 million in 2030 in Europe and from 29.79 million in 1970 to 77.64 million in 2030[5] In every disaster, including floods, there is always a potential risk of increased communicable diseases due to population displacement, overcrowding and decline sanitary conditions. Food scarcity is another situation which arises immediately after a disaster. Outbreaks of waterborne diseases are expected to rise with increases in extreme rainfall, floods and deterioration in water quality following wider drought events. [6] Heavy rainfall and flooding were the most common combination of events preceding outbreaks. [7]

Climate Change and Global Warming has become a serious threat to all the countries in the world. Many cities and urban areas in India are not able to keep with these challenges. Urban Flood Risk Management requires a multi sectoral and multi dimensional approach considering public health aspects. In urban areas in India, due to scarcity of land and high population densities, the numbers of casualties per flood disaster are much more than in other areas. Health risk due to floods in these urban areas is also very high due to lack of sanitation, leakage of water supply, drainage pipes, etc. Hence to cope with such crucial situations, management and control of the adverse consequences of floods will require coordinated and effective response systems at all levels-national, state,

district, local and community. Most of the components of response initiatives will remain the same for different types of disasters. These systems need to be developed considering the multi-hazard scenario of the region to optimally utilize available resources. [8]

To contribute in the outlook of urban flood response, this document makes an attempt to compile the observations made during the disaster response. Such literature can be a roadmap for formulating Disaster Management Plan for a country, state or district with regards to flood response practices and post flood recovery experience. Keeping with an aim to create better orientation, this in turn will help to reduce morbidity, mortality and speedy recovery.

Area of Study:

The state of Tamil Nadu in Southern India faced an onslaught of heavy rains during November and early December of 2015. The Indian meteorological department in their report said the exceptionally strong El Nino had resulted in the heavy rain. In Chennai alone, 1218.6 mm of rain was recorded which was three times the average monthly rain fall for the month of November, i.e. 407.4mm, making it Chennai's second heaviest monthly rainfall recorded in the past 100 years for November. The rains culminating to the highest recorded rainfall in a century resulted in the flooding of the state capital, Chennai and other districts such as Kancheepuram, Tiruvallur, Cuddalore, and Pondicherry that fell victim to nature's fury. The Central government declared it as natural disaster on the 3rd of December.

Chennai was one of the worst hit places during the heavy rainfall in Tamil Nadu. One of the largest cities in India, it is home to a large number of people and migrant population. Chennai is divided into 15 zones by the corporation which are further sub-divided into divisions. The assessment and analysis of the programmes and response to the 2015 floods is limited to Zone 4 since the authors were designated to this particular area for flood response activities. Other affected areas also had similar patterns of response with minor changes. Zone 4 is in the northern part of Chennai, adjoining the Bay of Bengal on the East, with Zone 1 to its North, and Zone 5 and 6 to its South.

The Population of Zone 4 is around 7.4 lakh with 15 divisions among which 8 divisions were the worst affected with a population around 4.5 lakh. Situated close to the sea, home to fisherman communities, this particular zone has a history of being vulnerable to endemics such as cholera. The Institute of Communicable Diseases (ICD) was the focal point from which health programmes were run. It is locally known as the cholera hospital as decades earlier a long epidemic of cholera resulted in numerous loss of lives and the hospital filled with cholera patients. All the response programmes for Zone 4 run by the government began

here at this hospital where the newer wing which functions as the teaching part of the hospital was used as the control room.

Methodology:

The documentation for this study was conducted as an external faction during the flood response in Zone 4 of Chennai city and all the activities performed was recorded. The documentation period was from 2nd December 2015 to the 17th January 2016 when the response was officially stopped.

Resource Mobilization:

Immediately after disaster, rescue operations were initiated with a simultaneous mobilization of human resources from unaffected districts. To oversee the response, to hasten administrative process and decision making, an experienced Administrative officer (IAS-Indian administrative officer) officer was deputed for the area as a "monitoring officer" who was performing as like head of incident command system for this particular area. Similar arrangements were made for all disaster affected districts in addition to the existing District Magistrate. Districts in India have District Magistrate (Collector) who is the foremost Indian Administrative Service officer, in charge of revenue collection and administration of a district in India. In metro cities such setting is not available at wards or zone level. The monitoring officer was the administrative head for all activities related to flood response. A Deputy Director of Health Services (DDHS) who is the head of a district for all health related activities was called in from other non-disaster affected areas. He was placed in charge of the management of Mobile Medical Units (MMU), medicine, staff related to sanitation and other response activities. A centre was established from where all the mobilized resources were provided various instructions on operations and were gathered every morning. A technical resource was assigned from a humanitarian organization for technical support and advocacy in this particular area to assist the monitoring officer in overall humanitarian response. Medical Officers, nurses, pharmacists and Health Inspectors (HIs) were brought from adjacent districts as part of RBSKY (Rashtriya Bal shishu kalyaan Yojana) project in their respective districts.

Mobile Medical Units (MMUs):

Twenty-five mobile medical units were formed, each comprising an ambulance, a Medical Officer (MO), a nurse, a pharmacist and a HI, all of them from non-disaster affected districts. The ambulances being utilized as MMUs were those earlier used in implementation of the RBSKY program. Three hospitals were non-functional and two partially functional during the initial phase. The objective of the MMU was to increase screening and provide OPD care services at doorsteps while the HI collects water samples from various tanks, sumps and overhead

tanks to detect the amount of residual chlorine through OT (Orthotolidine) tests from these places and sends the details regarding chlorine levels of the tested water to the Emergency Operation Centre (EOC). The HI's also checked the water contamination of the first and tenth house on the left of the street whose chlorine readings had to remain the same. If not, it meant that there was some problem with the pipe lines and needed to be investigated.

The MO compiles information on the total patients seen describing the cases with exclusive columns for Acute Diarrheal Diseases (ADD) and Acute Febrile Illness (AFI) in light of the disaster. The location for the camps to be conducted the next day camp was based on the incidence load derived for the data of the earlier two days. The data was collected at the ICD where a separate team was established for the analysis alone. The ADD and AFI cases were closely monitored and teams were sent to follow up on those patients. The data collected from the field was mapped at the ICD by the team set up for the analysis.

The programme was well managed with timely reporting being a major factor in the prevention of outbreaks of endemics in a high risk area.

Line listing and mapping of cases of ADD and AFI

It was decided that the information and line lists from all the 15 divisions in Zone 4 would be sent to the Zonal office. Surveillance and compilation would have to be completed by 11:00am the same day and the report and details of the analysis sent to the zonal office by 1:00pm the same day. This was to ensure that the reports could be studied and the zonal office would formulate the areas to be visited the next day. The office would also send teams to areas with a high number of cases to check the source of the problem at the source and if it can be mitigated.

One of the few challenges faced during the operation of the MMUs were the limited resources and larger area to cover which necessitated targeted locations

Figure No. 1

placed on the basis of certain analysis. It was very important to decide the priority area for MMU's camps as these are main source of syndromic surveillance during crisis time, which could help in rational utilization of the limited MMU's during the response. A criterion was decided to select a camp place based on analysis to decide how frequent the presence of the MMU is need in particular area was established. With aim that such practices could help in better implementation of MMUs.

To address this challenge large map (Fig No 1) of the zone was used for mapping areas where camps are conducted with pinned information about number of cases seen. Based on this, the location of the following medical camps were decided.

Bell pins were marked with the number and the date of the camp written below. This helped in immediate recognition of clustering of cases or if a one area continued to suffer from a high number of cases. It provided an immediate reading of the area to give e a picture of ADD and AFI cases noted over the last three days in one glance. This made it easy to read the health situation in the zone, by focusing on where the cases are increasing and decreasing so as to send in the health teams the following day. There was difficulty in marking the areas as the areas on the line lists and the map did not always coincide.

Displaced camps:

Numerous families in the city were displaced as the water level rose in the torrential rains. The families were evacuated and accommodated in schools and community places. Around twenty-four displaced camps were established in Zone 4 which had 806 families, with a total number of 2881 people residing there during the rains.

Adequate food and water was provided at the camps supplied by the government and NGOs. A small community kitchen was established by the government to address any immediate food requirements while medical assistance was provided through MMU camps.

The camps were initially not well regulated. Both men and women were residing in the same classrooms in one particular school. The numbers of toilets were inadequate and there was no division for male/ female sanitation due to which there was a risk of security issues and ideal place of sexual harassment. During this initial phase, there was no one person in charge of the camp to consolidate and maintain complete information of the camp. Some people were suffering from illnesses, there were patients with communicable diseases such as pulmonary TB with no access to medication and pregnant women were there as well. Regulation of food and water distribution from NGOs was another issue as

it had a huge potential for an outbreak. This did not last long as people did not stay here for a long duration since the waters had receded and the camps were also closed.

For future instances, a camp manager could be assigned for each camp to maintain data on the people and distribution of food and water. This would help the government regulate the number of people and the quality of food and water and quantity to provide.

Disinfecting houses and ensuring safe drinking water: Reaching out to flood affected houses with Bleaching powder and Chlorine tablets

The flooding had caused water to get into houses and stagnate for over a week, in some areas up to three weeks. The water mixed with sewage and dirt had to be cleaned up. For this purpose, rather than a normal cleaning, it was necessary to use bleaching powder to ensure a cleaner environment. The challenge was to reach each and every house in a timely manner with provision of bleaching powder to clean houses, sumps & overhead tanks. As drinking water may have also been contaminated, the community was warned to avoid tap water and usual sources of water. They were asked to make use of the water that was being distributed through tankers with a regulated chlorine level.

To carry out this clean up, 500 grams of bleaching powder was given to each house that was visited. Malaria workers were mobilized for this to ensure quicker delivery. Every division had ten to fifteen malaria workers who distributed the bleaching powder on bicycles through the streets. Anti-larval measures that they were doing earlier were suspended for the time being as water was stagnating within the houses itself and needed to be cleared out first. At each house, the family was explained about the use of bleaching powder, how to use it to disinfectant the sumps, overhead tanks, wells & clean water storage places as well as floors.

Auto Programme for IEC, distribution of Bleaching powder, chlorine tablets and outreach

The area is primarily home to fishermen communities and economically lower strata which raised the necessity for intense post-flood awareness. To reach a larger number of people in a short period, an auto programme was conducted with twenty-five autos, each with a health inspector and a twenty-five kg bag of bleaching powder, chlorine tablets and a recorded message in a portable speaker for IEC activity. The HI was mobilized from other non-affected districts.

The IEC message contained information about water borne and vector borne diseases that may crop up post floods, the method of using bleaching powder and chlorine tablets highlighting the importance of cleaning water storage and water stagnated areas. The message also stressed on the importance of sanitation and measures to be taken to prevent illnesses especially dengue. The HI was provided a mike to answer questions that may arise from the people. Regarding usage of bleaching powder, people were informed that 4gms of bleaching powder had to be used for 1000 litres of water to clean tanks or large quantities of water that would be used for cleaning the house and so on. Chlorine tablets of 10g had to be dissolved with 100 litres of water.

A lot of families in the city prefer to buy 20 or 50 litres of bottled water for drinking purposes. The private sector is involved in selling bottled water. There were a few houses in the same locality where people started to sell the 20 litres bottled water which made it hard to regulate the distribution while also causing concerns as they had lower levels of residual chlorine. This required quick outreach to the people to spread awareness. Twenty streets were covered by each auto per day which ensured that all the streets in the zone were covered and 124906 houses were reached. This was effectively implemented in this zone although it is not clear whether the same programme was replicated in other zones.

Entomologist's team to follow up of diagnosed ADD and admitted cases:

A team of entomologists was earlier conducting a survey to identify the source of mosquito breeding places. In light of the floods, they were utilised to do follow up of diarrhoeal cases, that is, patients who were admitted to the hospital. The teams worked in pairs. Details of patients diagnosed and admitted in hospitals in this area with acute diarrhoea were given to the team who would then visit the house of that patient, note the history of cases in the family and in the neighbourhood to ensure that other inhabitants do not suffer from the same issue and it was not spreading. Neighbouring camps, houses, hotels and schools were covered by them. This was to verify if it was a stand-alone case or if the problem was spreading in which case, it would be notified to the hospital and MMUs would be dispatched to the area. Due to the vast area, MMUs could not be present at all places which made the activities of these teams all the more important. They were also utilised to check the chlorine levels of the water and were provided OTS and kits to do the same. The teams had been in place to combat dengue a month before the floods, but due to the rains and subsequent floods, their work was increased to deal with the immediate need of combating ADD.

Village Health Nurses team for house to house visit:

The team comprised a HI, 3 Village Health Nurses (VHNs) and 1 Hospital Worker excluding the driver of the van. The VHNs were from different places and had volunteered to help with the flood response. The teams were to go house to house in the areas allotted to them. These teams went to the areas where MMUs had conducted camps. Their focus was to spread awareness on the causes and prevention of water borne diseases such as ADD and fever along with water contamination problems. They also stressed the importance of hand washing and boiling drinking water and hygiene related issues.

Each team was provided a kit to check chlorine levels and medicines such as Zinc tablets, ORS, Doxy as well as other basic medicines for those who were sick. For the extremely sick, they referred them to hospitals. Due to the floods, many developed fungus on their feet for which the teams provided ointments. They also gave 2 packets of sanitary napkins per adolescent girl in each house. The injured and pregnant women were all to be given TT. They also had bleaching powder bags to distribute if necessary.

Anganwadi workers: Utilising existing resources in water testing

There was always a need to scale up the activities for testing water in this zone, as it was majorly low economy community with poor sanitary conditions. To reach the slum population, the Anganwadi Workers (AWW) was identified as a resource for monitoring water quality people of the lower community were using. For this, the anganwadi workers were given chlorination kits and taught how to use them. They were asked to submit weekly and monthly reports and follow up on ADD/AFI by going to those areas and conducting chlorine tests after 3 days. They were asked to use the tests in the anganwadis and houses from where the ADD and AFI cases originated. They were also asked to note and report the results of the tests.

Reaching apartments through Residents Welfare Association of area

To reach out to the areas where residences where in the form of apartments in the area, a meeting with the representatives of the Residents Welfare Association was organised. An update on the activities and initiatives taken by the government was provided and orientation about public health initiatives, safe drinking water and identification of outbreaks was shared with them. There was no clustering of cases and they were all spread out which was pleasant news to a zone with a history of epidemics.

The office stressed the importance of using government products rather than private ones in light of the floods. While people preferred private suppliers to government ones in normal times, in this particular situation, government products were to be chosen as water was chlorinated and hygiene was ensured. Checkpoints were set up at the city limits to monitor the water tankers. Over 14 lakh food packets were distributed from the 1st to the 16th December in Zone 4.

Health coordination committee:

During the initial phase, it was hard to have information sharing between the government and private health sector and between the clinical and public health departments. Information sharing was lacking and the need for strengthening surveillance activity was required so as to avoid outbreaks. To address this and have a well functional surveillance system, a health coordination committee was formulated where representative from the corporation health department, curative and preventive, representatives from private hospitals, IMA (Indian Medical Association) representatives from that area and other related departments like Integrated Child Development Scheme (ICDS) department, education department, etc. attended the meeting. It was headed by the monitoring officer and facilitated by the representative of the humanitarian NGO.

Sanitation Activities		
1	Chlorine Tablets issued	23200
2	No. of Streets Sanitized with lime / Bleaching Powder	2520
3	Quantity of Bleaching / Lime Powder Used **(KG)**	48000
4	No. of Houses issued with 500gms bleaching powder pockets	124906
5	Quantities of Bleaching powder issued **(KG)**	62,500

Professional theatre for IEC:

To prevent the outbreak of dengue, the government hired professional theatre artists to perform plays in a few zones, particularly the highly vulnerable areas, on the causes of dengue and the precautions to be taken. This included the group decked out in costumes, complete with a doctor, families and a large, life-size mosquito. These plays were performed in the local language, for four days in each zone with three performances a day in different streets. This has become

a source of entertainment for the people as well as an awareness creating technique.

Medical Camp		11.11.2015 to 08.01.2016
1	No. of Medical Camps	1795
2	Total No. of Beneficiaries	325919
3	Fever Cases Detected	3380
4	ADD Cases Detected	1698
5	Sanitary Napkin Issued	59970

Impact of activities:

During the period of 2nd Dec 2015 to the 17th Jan 2016, 325919 beneficiaries were reached through 1795 medical camps conducted by MMUs. Among this, the majority were women who received sanitary pads. 1698 patients suffered from ADD and 3380 patients from AFI. No outbreak was reported in the intervention area.

During the response, a total 124906 houses were reached with bleaching powder, chlorine tablets and IEC activities covering almost every house in the zone. About 62,500 kg of bleaching powder and 23200 chlorine tablets were distributed. 2520 streets were sanitized with bleaching powder.

Cases	November		December	
	2014	2015	2014	2015
Fever	200	195	242	279
ADD	59	99	57	178
Leptospirosis	-	0	-	4
H1N1	0	0	0	0

To get an overview of the impact of the response activities, the data on diseases in 2016 during November and December (period of most rainfall noted and major part of response was initiated in 2016) was compared with the data of the same period, that is, November and December of the year 2015. Major vector borne diseases data was compared such as AFI, ADD, Leptospirosis and H1N1.

Discussion:

India recently formulated Disaster management plan a decade after the mandate of the Disaster Management Act came to exist. While many critics commented

about the plan being too generic & absence of actual road map in the DM plan specifically on resource mobilization and response. There is an opportunity in Disaster Management Plan of country state or district to be more specific and clear in regards with response activities. [9]

The risk of an outbreak post disaster mostly depends on the endemic levels of diseases in the population. These include diarrhoea, dysentery, cholera, measles, etc. This particular zone had a history of endemics, of water borne and vector borne diseases. Establishing good surveillance post-floods has paramount importance more so than in other disaster scenarios. Along with that, screening of individuals is also highly important. It is observed that in post disaster scenarios of any kind, generally static medical camps or tents are established by Humanitarian organization but MMUs are required to reach out to the maximum number of people and to those who are unable to reach the static camps. A well planned system of MMUs can help to restrict the outbreaks and provide an opportunity for syndromic surveillance which is needed in such crucial situations. Similar observations about MMUs was made stating, such surveillance activities serves multiple functions during this response which includes prompt evaluation of trends in diagnoses and assessing unmet needs. [10] Adding to this, another observation was that with help of MMUs, diagnosis of ADD and AFI cases is achieved in earlier stages which reduced the chances of hospitalization of those patients, due to the early detection. Its good opportunity to merge any another response related program with MMUs activity, as it did helped to implement the other activities like detecting residual chlorine level at house to house by adding one Health inspector staff in the team of MMU. He can also conduct IEC activities along with.

One of the few challenges faced during the operation of the MMUs are the limited resources which necessitated targeted locations placed on the basis of certain analysis. A criteria to select a camp place and how frequent it is needed the presence of the MMU was established. Such practices could help in better implementation of MMUs.

Swift decision making in disaster is of paramount importance and in such situations, individual departments performing parallel work will not yield desired results. It may be right from revenue to logistics, health to engineering, sanitation to education etc. In such situations, having a single authoritarian position at the implementation level will help make inter department decisions quicker. The authority should have all the departments under him as many of the resources are pooled from different geographical areas and hence need better coordination. Keeping this in mind, such an arrangement is already mentioned in Indian Disaster Management Act, 2005 about the role of the District magistrate/ District collector (IAS cadre) as the focal person for all the disaster related

activities. [8] This was observed during this disaster response. As per NDMA Act 2005, the District collector is the focal person for any disaster related activity such as response management and coordination. What is lacking is the posting of a senior cadre monitoring officer. In this current response, there is evidence where the importance of having a disaster experienced administrative head will act as crucial step as District magistrate in not the authoritarian official person in urban areas.

The need for technical support was felt during the response where having an advocacy support through disaster response experienced individual from humanitarian organization will help in designing response strategies, identifying the opportunity to maintain standards, monitoring of activities, establishing coordination between various departments of health in the government system and also maintaining GO and NGO coordination which is crucial for sharing the resources.

Conclusion and Recommendations:

The response was successful in many terms, especially in avoiding post-flood disease outbreaks despite the affected area's history of epidemics and many endemic diseases. A well-organized system of MMUs will help to provide competent means to conduct syndromic surveillance, to reach out larger population which is the need of hour and to avoid outbreaks. These MMUs should be planned & based on proper analysis so that it is meticulously utilized in resource constrains settings. One of the recommendations will be scientific implementation of MMUs. Having an administrative officer as head of the operations at ground level, who will be a single hierarchy in decision making this helps to hasten the response process and maintain coordination between various departments. A humanitarian response expert with an orientation on public health aspects and other disaster response standards will be a good addition to the team providing technical support to the existing government system to identify & address the needs which arises post disaster, maintain coordination and ensure quality implementation of disaster response. Such literature of activities can be used for formulation of DMP to make it more e specific providing actual roadmap.

References:

1. E.Quarantelli. The future is not the past repeated: projecting disasters in 21st century. Journal of contingencies and crisis management:1996:4;228

2. M Wahlstrom, Debarati G. The Human Cost of Weather-Related Disasters 1995-2015. 2016:5-13

3. Parry, M.L., Canzian, J.P., van der Linden, P.J., Hanson, C.E. (eds). (2007) ClimateChange 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved from https://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch3s3-5-2.html.

4. Liao, K-H. (2012) A theory on urban resilience to floods: A basis for alternative planning practices. Ecology and Society, 17; 48- 62

5. Field, C.B., V. Barros et all. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation .IPCC:2012;5-18

6. Pachauri RK, Reisinger A (eds). Contribution of Working Groups I, II and III to the fourth assessment report of the Intergovernmental Panel on Climate Change. IPCC, Geneva,Switzerland(http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html). Accessed 25 June 2012

7. Cann, K.F. Thomas, D. R., Salmon, R. L., Wyn-Jones, Kay, D., Extreme water-related weather events and waterborne disease, Epidemiol. Infect. 2013:114

8. National disaster management guidelines. Management of floods.2008:8;11-63.

9. http://www.hindustantimes.com/analysis/the-new-national-disaster-management-plan-has-several-flaws/story-LrHOFHXg9gwrtOgYjXJDrK.html

10. Melani.M et all. Mobilizing Mobile Medical Units for Hurricane Relief: The United States Public Health Service and Broward County Health Department Response to Hurricane Wilma, Broward County, Florida. J Public Health Management Practice, 2007, 13(5), 447–452

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Major Fire Accident At M/S Biomax Fuels Ltd Vsez, Duvvada On 26.04.2016

Dr G Trinadh Kumar, IFS

Introduction:

Visakhapatnam Special Economic Zone (VSEZ) is a Central Government Special Economic Zone (SEZ) and is also one of the Zonal Offices under the Ministry of Commerce & Industry to look after the SEZs and 100% EOUs located in the States of Andhra Pradesh, Telangana & Chattisgarh and also Yanam (Part of Puduchhery U.T.). Visakhapatnam Special Economic Zone is spread over an area of 360 acres land which is fully developed and allotted to various industrial units. VSEZ is located at Duvvada village of Visakhapatnam Dist. and is well connected through Rail, Road and Air for easy movement of cargo & human resources.

M/s. Biomax Fuels Ltd manufacture of Biodiesel (PME/AME/UCOME) as main products and usual Glycerin and CPME Concentrate as by products. The unit is spread over an area of 66404 sq. mts that falls on either side of the road passing through the zone (VSEZ). The plant area is divided into **manufacturing block** which including plant & Machinery and Methanol storage tanks and is located on the SE side of the road and **Storage tank farm** which includes Raw Material (RM)/Finished product storage tanks and is located on the NW side of the road. (Location/Site plan Enclosed).

The plant is having a production capacity of 750 tonnes/day and it employs about 200 persons. Storage tanks for RM, Finished products, Methanol are an essential part of any Biodiesel plant. The storage capacities installed in M/s Biomax Fuels Ltd is as follows :

1)	RM storage tanks (12 tanks of 2700 KL/each tank) **(Fire accident occurred in these Tanks)**	: 32400 KL
2)	Finished products storage tanks (6 tanks of 6800KL/tank)	: 40800KL
3)	Methanol storage thanks (4 tanks of 500KL/tank)	: 2000KL
4)	High Speed Diesel tanks (2 tanks of 500KL/tank)	: 1000KL

The Biodiesel plant is located in an area admeasuring about 16 acres land which is divided mainly into production block (about 9 acres) and storage tank farm (about 7 acres). Production block area consists of three manufacturing blocks, utility block, solvent (Methanol) storage area, solvent recovery area, Control Room and other amenities/utilities like Generator, Cooling towers, Pump house

etc. Tank farm area consists of 12 nos. of Raw Material Storage Tanks, 6 nos. of Finished Products storage tanks and finished product loading bay.

Existing Fire Fighting Systems in the Plant

1.	Fire water hydrants	- 62 Nos
2.	Fire Extinguishers	- 83 Nos
3.	Fire water tank/sump	- 700 KL capacity
4.	Fire Fighting pump (electrical)	- 273 m3/hrs capacity
5.	Fire Fighting pump (diesel)	- 273 m3/hrs capacity
6.	Jockey pump	- 10.8m3/hrs capacity
7.	MVWS system for Methanol tanks.	

The Accident:

On 26/04/2016 at about 19.35 hrs (as per CCTV Footage) a fire broke out in the RM tank farm followed by a flash at about 19.41 hrs in the dyke area. Fire spread through the pipeline initially towards finished product loading bay where in 2-3 tankers (trucks) were kept ready to fill and transport the material. Truck drivers and the operating staff working in the loading bay ran away from the spot leaving the trucks in the bay area. No effort appears to have been taken by the staff immediately to douse the initial fire/spark by activating the water hydrant system in the Tank farm.

Possible Source of Ignition

Fire started from an electric pump located between RM tanks. CCTV footage shows that the source of ignition was a spark/flash from the electric pumping motor probably due to short circuit or malfunctioning of the pump. The crude Palm Fatty Acid distillate oil (PFAD) inside the pipeline and large quantity of spillage in the dyke wall area provided sufficient fuel for the fire to spread.

Fire spread within the dyke wall and affected all the 12 RM storage tanks within about 2 hrs. time from the initial ignition.

Fire Fighting Operation in Chronology :

Fire broke out in storage tank area from an electric pump at about 19:35 Hrs. No attempt seems to have been made to fight the fire in incipient stages, which might have caused the fire to develop into gigantic proportions. Trucks parked at gantry for loading/unloading were later affected by the fire. The drivers and operators escaped from the spot. Fire crew of the AP Fire Service Station, Gantyada was informed at about 20:00 Hrs and the crew reached the spot at around 20:30 Hrs. CISF Fire station, VSP was intimated about the

fire incidence at about 21:00 Hrs and first turn out crew of main fire station rushed to the sport with foam tender. First turn out crew of VSP reached the fire spot and observed that massive fire broke out in some of the crude bio fuel storage tanks.

Fire crew of A.P. State Fire & Rescue services, and nearby industrial fire brigades and Eastern Naval Command were summoned to the fire spot. Considering the severity of fire, VSEZ Administration requests DC/Fire CISF, VSP for one more foam tender and the second turn out crew main fire station was also pressed into service. Development Commissioner & Joint Development Commissioner along with other staff of VSEZ were the first to reach the accident site and co-ordinated with the District Administration for deputing the fire service into action. Shri Ganta Srinivasa Rao, Hon'ble HRD Minister, Shri N. Chinarajappa, Hon'ble Home Minister, Shri P. Srinivasa Rao, Commissioner of Police, District Collector and other higher officials of state also arrived at the spot. Fire completely affected eleven out of the twelve tanks causing an inferno like condition within the dyke creating a hopeless situation for the officials to carry out any aggressive firefighting to douse it completely. DC/Fire,VSP discussed the situation with, VSEZ officials, District Administration and concerned plant officials to gather information on the nature of crude bio oils, vital and hazardous installations near to the fire affected crude tanks of the plant, CISF Fire Wing rapidly charted out an apt fire fighting strategy.

VSP fire crews were divided into six teams. First team concentrated to prevent the running fire over the connection process pipe line between crude tanks and highly inflammable catalyst (Methanol) storage tanks located across the road. Crew immediately attacked the running fire and provided sand filling at the pipe as a fire stopper and completely prevented the spread of fire to the Methanol thanks thus averting, a major catastrophe. Second team started foam pouring over the fire affected crude tanks with foam fire tender. Personnel approached the fire affected tanks despite extreme heat radiation. All of the attack tenders were supported and replenished by the State and other fire brigades from a safe distance. The third fire team of VSP started water cooling of the nearby unaffected tanks (finished product storage tanks) with other fire tender. One high expansion and two medium expansion foam generators were pressed into service for flooding foam in the dyke wall area to prevent the spread of fire towards finished product storage tanks. The fourth team was formed as support to the fire fighting activities of VSP fire crews for ensuring supplies of foam and water and also to coordinate with other outside fire brigades. The fifth team was engaged in timely mobilization of equipments and reinforcement and communicating with Main fire station/ VSP. The sixth team was stationed at VSP Main Fire Station for arranging and transporting the necessary logistics and reinforcement to the spot as and when demanded by the fire crews. The

crew members of fourth and fifth teams were also utilized in fire fighting on rotation basis.

1. Due to huge quantity of flammable bio diesel raw materials stored, the fire fighting turned into a herculean task for all of the fire fighters.

2. Tanks engulfed in fire were deformed and started bulging and cracking at several places causing huge quantity of raw bio oil spill into the dyke area.

3. All the remaining fire brigades at the spot were continuously engaged in replenishing the exhausting water as well as foam supplies to VSP Fire crew.

4. Unfavorable wind conditions also increased the magnitude of fire, raising the temperature around the unaffected tanks, including the 06 vital finished product storage tanks. This situation forced us to re-evaluate the existing fire fighting strategy, so that the 06 finished product tanks could be saved at any cost. Accordingly, one of the operational VSP Fire crew was relocated to the spot, after handing over the fire fighting responsibility to CISF Fire crew and SSTPP Simhadri and adopted a defensive fire fighting strategy to save the 06 final product storage tanks, unlike the aggressive fire fighting which was going on in the Raw Material storage tanks.

5. First and foremost laborious task in front of the fire crew was inadequacy of approach routes towards the 06 storage tanks. The officials of the concerned firm were called to spot, and asked to bring down the perimeter wall of the open area which was done using a bulldozer. VSP fire crew along with one of the foam fire tender penetrated through the way created and positioned the fire tender at a safe working place inside the bio fuel storage tank complex.

6. Some of the crew members with full PPEs (including proximity suits) as well as water spray protection from rear, entered through the nearby platform. The crew started pouring foam and simultaneously provided water curtain at different places between the groups of tanks i.e. Raw Material and finished product tanks. After continuous and rigorous fire fighting, the crew succeeded to create a cool wall between the groups of tanks and protected the 06 tanks from the radiant heat that had raised the ambient temperature around and from the flames of the affected tanks touching the finished products tank.

7. The fire had wrecked the crude oil tanks. The crews deployed at night were relieved in the morning of 27.04.2016, exhausted but with high spirits. The crew with fresh legs continued to sustain the fire barriers created with foam

and water between Raw Material tanks and finished product storage tanks. The fire fighting operations continued round the clock on 27.04.2016 as well with the same vigour by rotating the staff and replenishing the water and foam supply. With the continuous efforts, the fire has been contained to the dyke area without the possibility of further spread to adjoining areas.

8. Fire fighting was continued on the third day (28.04.2016) also and by 16:00Hrs, the fire was brought under control though not completely mitigated. Some of the foam tenders were withdrawn from the spot.

9. The fire crews then concentrated mainly on cooling the ravaged tanks and preventing re-ignition. This continued till 30.04.2016. The final crew from VSP and other agencies were withdrawn on 30.04.2016, almost 100 Hrs after the initial ignition. However, two fire tenders were kept in place in standby to control any sudden reignition of fire in the tank farm.

10. More than 40 fire tenders of various fire brigades in and around Visakhapatnam attended the call and extended support in fire fighting. Almost 120 Kilo Liters of foam compound was consumed during the fire fighting, of which 10,000 Liters were provided by VSP Fire Wing.

Interventions that Yielded Good Result.

Plant Head of Biomax and Security officer of VSEZ immediately contacted the Fire Officer, Pedagantyada and then intimated the DC & JDC, VSEZ about the incident. Senior officer's viz., DC, JDC, Police Commissioner, District Collector and Peoples Representative viz., Shri Ganta Srinivasa Rao, Hon'ble HRD Minister, Shri N. Chinarajappa, Hon'ble Home Minister, Shri P. Srinivasa Rao, and Hon'ble MLA reached the spot to ascertain the situation and take appropriate action to douse the fire. VSEZ officials in co-ordination with District Administration and Police authorities organized mobilization of fire tenders from nearby areas and could mobilize about 40 fire tenders from various organizations like State Fire Department, RINL, SSTPP Simhadri Fire Wing, APSEZ, Laurus Labs fire tenders etc. to the spot within 3-4 hrs of the incidence. Though the fire tenders from district fire services reached the spot first, they could not go near to the tank farm and start any fire fighting immediately due to very high temperature and also fast spread of fire from one tank to other in the initial hours.

The lids of some of the RM tanks were blown off to about 100 feet height. Within short time the fire spread to all the 12 Raw Material Storage tanks existing within common dyke walls and fire started spreading towards the main plant area through the underground pipe line laid across the road. Fire tender of M/s Laurus Labs was taken towards the culvert wherein the underground pipeline

is laid from RM tank farm to the main production plant and doused the fire spreading towards main road through the pipeline using foam & water. Once the fire is doused, a JCB was brought to the area and filled the culvert area with soil and prevented spread of fire towards main production plant & Methanol tank farm. Thus, arrested a possible major catastrophe due to timely action. On the next day after sunrise, the pipe line was completely disconnected to prevent any fire spread through the pipe line.

Fire tenders were continuously deployed and water sprayed throughout night in this area to control rising temperature and fire spread towards Methanol tank farms & production block. Thus the area beyond road was secured. RM tank farm was not directly accessible for the fire tenders to be taken close to the Raw Material storage tanks from the main road. Therefore, the boundary wall between the RM tank farm & adjoining unit was broken using a JCB and the fire tender were moved into the open area adjacent to RM tank farm for fire fighting. Next major challenge was to prevent spread of fire from RM tank farm (all the 12 tanks caught fire & burning) to the finished products tank farm which is separated by a small pathway and all the 6 thanks have finished goods (Biodiesel) in them. Two fire tenders were deployed exclusively to spray water & foam between the RM tank farm & Finished Goods tank farm.

Thus a defensive fire fighting strategy was adopted to save the six finished product storage tanks unlike the aggressive fire fighting which was going on in the RM tank farm. This effort was continued and successfully prevented spread of the fire to the tank farm having finished products (6 tanks). After taking enough care to prevent the spread of fire to adjoining areas (FG tank farm & the production & Methanol tank area) the fire could be restricted to the RM tank farm alone during the night long fire fighting on 26/04/2016 and following day (27/4/2016). Other biggest challenge was to supply enough water and foam for the fire fighting operation. Fortunately, VSEZ has got enough water availability but filling into the fire tenders was a challenge as there is no overhead filling facility. With the help of operational pump sets existing in the Zone & other units Viz. ACC Ltd, Gland Pharma, DRL etc., the water supply and filling into the fire tenders could be managed.

GVMC was contacted to resume constant pumping of water from Meghadrigadda reservoir to VSEZ (an existing dedicated line through which VSEZ sources water for the Zone) and thus the water was ensured for the entire operation. Foam is the next essential material which is in short supply to continue the fire fighting operation. Various institutions and industrial units were contacted through VSEZ, police and General Administration for mobilizing foam from HPCL, RINL, Simhadri, Phama units like Divi's Labs, DRL, Laurus Labs, Mylan etc. Every organization has co-operated in their possible ways and sufficient

quantity of foam could be organized and used for the complete operation which was conducted for about 6 days. Fire fighting crew from Navy was deployed throughout the operation and apart from regular conventional fire fighting operation they tried to air drop the fire extinguishing chemical into the RM thanks. However, due to unfavorable wind, the chemical balls airdropped have missed the target on repeated efforts and hence the same was abandoned. In general mob management becomes one of the difficult tasks in such situations.

However, in the instant case, it was prevented by restricting the entry of people into VSEZ premises by regulating the entry gate and the back gate was completely closed during the entire period of operation. The entire operation stood as an example of inter departmental co-ordination especially among the Central Govt., State Govt., Armed Forces and Corporate bodies including Public Sector organizations in mitigating the world's largest fire accident in a Biodiesel plant.

Postmortem of the Accident

a. The pump operators and truck drivers on seeing the initial flash did not operate first aid fire fighting equipments and neglected flash coming from the pump which shows lack of fire awareness and first aid fire fighting training for the workers. It is pertinent to mention that, tending an oil fire in the first few minutes would avert major fire mishaps in such industries.

b. Delayed information to nearby fire brigades after the initial fire.

c. Lack of automatic detection and fire protection systems at the tank farm area. No provision of automatic Foam flooding systems exists in the Tank farm area.

d. Lack of continuous provision of pressurized fire water at the spot.

e. A temporary shed has been erected along the dyke for keeping LPG and Oxygen cylinders, which is not recommended.

f. No SOP seems to be in existence to handle On-site & Off-site emergencies. Designated persons to handle such situations should be nominated.

g. Though there are more than 100 production Units, no designated Fire tenders or fire teams are stationed in the VSEZ.

h. The nearest State Fire Station is about 15 kms away from VSEZ.

i. The company claims that the affected tanks contained only the raw material (PFAD), which does not easily catch fire. The highly inflammable solvent methanol is mixed in the process. The mixture may have been stored in

some of the affected tanks for Transesterification. The Methanol in this mixture might have caused the fire to aggravate and spread to other tanks quickly.

j. The Dyke around the tanks was not as per standard norms.

k. The fire water hydrants around the dyke were not positioned as per standard norms and were installed within the dyke.

l. The tank to tank distance also was not maintained as per norms and is not in accordance with regulatory acts like petroleum act.

m. There were no provisions for easy access of emergency vehicles close to the tank farm area.

The fire accident happened in the biodiesel plant is one of the largest accident in the world in a biodiesel plant. Some interesting facts involved in the accident are furnished below:

Sl. No.	Description	Unit	Quantity
1	Quantity of bio oil (RM) burnt	MT	26875
2	Value of the material burnt	Rs in Cr.	96.04
3	Estimated loss to the physical structures	Rs in Cr.	19.48
4	Production loss due to the accident	Rs in Cr.	210.00
5	Estimated expenditure for the fire fighting operation	Rs in Cr.	1.32
6	Quantity of AFFF Foam used (approx.)	KL	120
7	Quantity of water used (approx.)	KL	2000
8	Number of days of fire fighting operation	Nos	6

AP Pollution Control Board assessed the situation and reported that the accident has resulted in generation of 700 KLD of waste water, thick dense smoke containing palmitic acid and oleic fumes.

The entrepreneur of the unit could not start the production even after the passage of 8 months time since the fire accident due to various associated problems like, non availability of working capital, loss of orders in hand, considerable time and resources are required for the reconstruction of new tank farm etc.

Conclusion

The case presented here appears to be the world's largest fire accident occurred in a Biodiesel plant. The units claim that they have stored 'only crude raw

material without mixing it with Methanol' appears to be not correct as the crude raw material generally do not catch fire upto 90° C or more. The possible causes of occurrence of fire in the tank farm appears to be static current/short circuit but it has spread over all the tanks due to presence of highly inflammable material, probably Methanol content in the material stored in the tanks. This can only be known once the statutory authorities/forensic experts furnish their report. This incidence, though an unfortunate one, can be seen as an example of the inter departmental coordination at the district level and teaches lot of lessons.

** Joint Development Commissioner, Visakhapatnam Special Economic Zone.*

Planning, Analysis & Review of Mock Exercise: An experience of IOC Depot

Durga Prasad Mohapatra

Abstract:

Population in India is increasing alarmingly with an alluring rise in the risk and vulnerability to the hazards of natural and man-made disasters like Fire, Earthquake, Flood, Landslide, Avalanche, Industrial fire, Domestic fire, Riots, Chemical Biological, Radiological and Nuclear Disaster. The population is living in precarious housing structures that could be seriously affected in any disaster of considerable magnitude.

The mock exercise aimed at accelerating the pace of development of response plans for the district and promoting a culture of preparedness. The drill is also meant for bringing together different departments and agencies providing the emergency support functions for a better coordination.

Scope of the drill:

This response mechanism can also be followed to combat any other natural calamity or destruction planned by human beings (terrorist activities etc.) by suggesting suitable changes in the standard operating procedures of the emergency response functions.

Aim:

1) To test the District Emergency plan (Earthquake off-site emergency plan) as per Disaster Management Act 2005.
2) To find out the response mechanism of various government departments.
3) To find out the alertness and response time of personnel involved in the mock drill.
4) To evaluate the performance and inviting suggestions for further modifications and strengthening the plan.
5) To find out the effectiveness of the communication system.
6) To observe the commitment of team at every level for controlling earthquake disaster.
7) To find out the clarity in role & responsibility.
8) Communication between various response groups.
9) To Educate and create awareness among the citizens.
10) Sequence of events should be properly planned.

Need and rationale of conducting an on-site and off-site mock-drill:

1) The importance of such an exercise:

- Such mock drills pave the way for preparation of disaster recovery plans. The plan once prepared should be used/implemented in any crisis management whenever the district encounters it. The plan should be reviewed after every crisis/disaster, which will keep refining it. Use and reuse of the same well documented and constantly refined plan would eventually move towards perfection and maturity and the system would get accustomed to use standardized procedures. Slowly and gradually it will come out as a success story for the district whenever a major mishap takes place.
- This mock drill aims to create a first documented crisis/disaster management plan. Further another document should be created for an implementation plan for all related departments. It should clarify how various elements interface with each other and it should be so simple that without an emergency meeting any disaster could be fought very easily and quickly.
- General perception/mindset that nothing disastrous is likely to happen in my vicinity.
- The after effects of Earthquake, for which normally we are not prepared and have no forecasting.
- In Earthquake, majority of the casualties occur because of collapse of buildings/petrol tanks at depot.
- Inadequate preparedness of concerned defense mechanism increases the risk factor for community.
- Evacuation plan from the building/campus or from the community may be inadequate or less effective.
- Industrial infrastructure, processes and personnel not as secure as presumed to be.
- This will provide an opportunity to revisit various stages of operations.
- A good way to test Disaster Management plans and preparedness/response capability of critical individuals and the general chain of command in a depot/industry.
- Mock-drills and tabletop simulations help spell out strength and weaknesses.
- Establish linkages with community and civil administration etc. and for various other reasons.

2) Activation of the scenario on day of drill --- in sequential manner as per the scenario prepared.

3) Post observers [independent] at each crucial stage to monitor response and conduct.

4) Evaluation of the performance at review meeting.

5) Lessons Learnt by each working group.

6) Debriefing Meeting [preferably by DM or a senior District Officer] with all jointly to highlight the achievements as well as the shortcomings etc. and determine the future course of action to improve the same.

7) Periodic review of plan & field visit– not to lie in a desk.

The steps followed in framework of mock-drill

- Analysis of the overall hazard and vulnerability profile of the region with enumeration of past history.
- The impact of such happenings in the region with casualty and damage details and assess probability of such occurrence in the area.
- The response mechanisms, the resources and the expertise available within the vicinity, within the district and the state, which can be summoned in case of an emergency.
- The nature of industries in the region along with details of the raw materials, chemicals and products handled/produced by them posing a threat to or facing a threat from external/internal happenings and processes.
- Development of an appropriate disaster management and preparedness plan with assignment of specific responsibilities & roles and training of personnel in their specific areas of response for e.g. Civil Defence & Home guard capacity building was done in the field of rescue.
- Need to involve the staff/personnel in developing the plan in order to ensure 'ownership' (for an on-site plan) and other stakeholders and agencies (for an off-site plan).
- Enlisted internal and external resources and capabilities.
- Preparing and sharing the disaster preparedness plan within the organization and with agencies outside with which linkages are required to be established with enumeration of the specific roles and responsibilities they might be required to perform during an emergency.
- Analysis of threat posed to and by each industry on the basis of credible worst-case scenarios and their prioritization accordingly.
- Audit current level of preparedness in terms of threat and vulnerability.

- Assess gaps (Gap Analysis) in preparedness levels – both internal and external.
- Review response to past incidents and develop an action plan to strengthen the same.
- Revisit mechanical operations through periodic examination of machinery, pipes and fittings.
- List of resources available within and outside the premises and likely to be mobilized at a short notice.
- Emergency planning with assigning of roles and responsibilities within a well-defined chain of command.
- Mutual-aid agreements with neighboring depots/industries and organizations for developing mutually supportive assistance protocols.
- Familiarize employees and contractors with emergency response and their roles.
- Proper understanding of procedures by all.

Background/ Scenario development:

Due to Earthquake IOC Depot, Indore Petrol Tank (Big Size) was tilted and petrol leakage started. IOC depot staff tried to decant the petrol of tilted tank to another tank so that petrol should not be wasted & also for reducing the risk of fire. When this operation was going on, suddenly thunder lightening took place and an earthquake hit the area; Earthing in this area damaged and leaked petrol caught fire; Administrative building severely damaged. Thirty persons found trapped in the building. Another Petrol tanker at IOC gate parking caught fire and nearby houses are on risk of fire. The fire also melted the hydrant pipes of the IOC and due to varying wind directions chemical fire also started affecting outer areas of the incident site. Other hazardous installations like Hindustan Petroleum, Hindustan Petroleum Bottling plant; Bharat Petroleum depot and BPCL terminal are also located just adjacent to the Indian Oil Corporation Depot. Situation can aggravate suddenly if railway-diesel storage shed or train passing through the railway line also catches fire.

IOC depot as per their On-site emergency plan started the fire fighting operation and informed all the mutual-aid partners M/s HPCL, BPCL, HP Bottling plant, BPCL terminal. Even then destruction was not controlled they have called the meeting of Expert group under the chairmanship of local crisis group and decided to inform District Crisis Group to declare Off-site emergency accordingly siren was blown and Chairman of District crisis management, Police, Fire & Municipality were informed. About 50 people affected and many are captured in the IOC, Slum and railway diesel shed. Situation got out of control of IOC.

Therefore, a state of emergency needs to be declared and rescue operation started in partnership with District Crisis Management group.

Pre-Mock drill meetings:

(A) District Administration office: District Collector convene a meeting of District crisis management group to discuss the job responsibilities on Off-site Emergency mock drill in IOC depot. In meeting assessment should be done on nearby hazardous units, mandatory rules of Factories Act. The entire supported plan work, District Crisis group members telephone/ mobile no's and scheduling of time of the events & activities along with the responsibility chart to be circulated among the stakeholders. Emergency Support Functions and Standard Operating Procedures were discussed in detail. It is decided to conduct the mock drill with date/ time or a surprise without mentioning time and it may be informed that any day people would be informed to attend the mock drill.

Working Group Job Responsibility in Earthquake Mock exercise

	Designation & Mobile no.	Responsibility/ Functions
Administration		
1	Collector & District Magistrate	To supervise and monitor the complete earthquake mock drill at Emergency Operation Centre (Control Room)
2	Add'l District Magistrate	To coordinate and control all the activities of various agencies at the incident site.
3	SDO & SDM	To help ADM in coordination and communication, Take care of evacuation and shelter point, Monitoring the evacuation operation.
4	Project Officer, DRM, UNDP	Assist ADM in coordination of mock drill and documentation
Department of Police		
5	Superintendent of Police	Maintain peace and harmony at the site & around the city
6	A.S.P., Rural	Coordinate with the S.P.
7	A.S.P., City	Control all the activities of cordon of the area and inform all the public by public address system about the mock drill and evacuation to avoid panic.

	Designation & Mobile no.	Responsibility/ Functions
8	C.S.P. D.S.P.	Help in evacuation and shift the public to a shelter place.
9	SDOP	Remain in central room at IOC gate to handle press/media and relatives of the people with Public Relation Officer.
10	Incharge, Police Chowki Sarpanch	Help the officers in coordinating the evacuation, shelter arrangement, Drinking water, Breakfast and arrangement of two buses.
Department of Fire		
11	DIG, Fire/ S.P. Fire	Monitor all the activities of fire control and rescue operation in the damage building and controlling of fire from the control room. He will instruct the movement of various fire brigade vehicles to the place of incident.
12	DSP, Fire	Carry out the rescue operation through rope, ladder and manually lifting the victims. He will also monitor the fire fighting activities at the incident place.
Municipal Corporation		
13	Commissioner, Municipal Corporation	Monitor all the activities of movement of victims, Building damage control, movement of rescue vehicles and water supply.
14	City Engineer, Municipal Corporation Chief Health officer, Municipal Corporation	Monitor all the activities at site, movement of victims and removal of debris using JCB, bulldozers for rescue operation. To monitor the health, food, drinking water for victims at shelter home.
Hospital		
15	Superintendent, Hospital	Will be informed on telephone about the incident and will arrange to send ambulance with Doctors & Nursing staff to the place of incident.
16	Dean, Medical college Civil surgeon C.M.H.O.	They will remain in the duty at Hospital to provide all required help and to provide treatment to the victims. They will recommend and shift serious victims to airport and railway station for outstation hospitals after providing emergency treatment.

	Designation & Mobile no.	Responsibility/ Functions
17	Medical Superintendent General Manager, (Stakeholder from Private Hospital)	Will send ambulance along with Doctor & Nursing staff to lift the victim from the place of the incident. Arrange extra bed at the hospital & other arrangements for emergency operation. He will recommend and shift serious victims to airport and railway station for outstation hospitals after providing emergency treatment.
Pollution Board		
18	Regional officer, Pollution Board	Will remain at the place of incident to monitor the environmental pollution because of Hydrocarbon fire in that area and report to ADM.
Western Railways		
19	Station Manager PRO	Will control both-way railway traffic To/From during the event to avoid any escalation of fire in the moving train. Will arrange emergency seats for seriously injured patient to be shifted to metro city.
Airport services		
20	Director, Airport	Will be informed by telephone to monitor the arrangement of shifting the serious patients to metro through the first available flight. Make arrangements at airport providing required help to patients and attendants.
21	Manager, Fire & Safety, Airport	Will send one ambulance and CFT (Crash fire tender) to the place of incident and will carry out fire fighting and building rescue with help of hydraulic cutters and expenders etc. Will work in coordination with city fire Brigade.
Road Transport Corporation (Bus service)		
22	Manager, Road Transport Corporation	Will be informed to provide two empty buses along with Driver and two conductors for the evacuation and shifting the public of town to the shelter place and control the movement of buses at National Highway.

	Designation & Mobile no.	Responsibility/ Functions
	Traffic Police	
23	DSP, Traffic (East) DSP, Traffic (West) Thana Inspector (East) Thana Inspector (West)	Will control the traffic at different location during the mock drill. Help the movement of fire tenders, Ambulances, VIP vehicles at the place of incident.
	Industrial Health & Safety	
24	Director Deputy Director (Industrial Health & Safety)	Will monitor all the activities of rescue, fire fighting, first-aid and health in the IOC depot in coordination with the Deputy Director of the area.
	Electricity Department	
25	Chief Engineer Executive-Engineer, Electricity	Keep there staff ready to cut the electricity supply if required in the incident place.
	Development Authority	
26	CEO	Control the activities of damaged building at the place of incident.
	Public Relation Department	
27	Joint Director, Public Relation	Make the wider publicity of the mock drill before hand and also make wider publicity of the successful completion of mock drill.
28	Press club	To publicize widely about the mock drill to create awareness to the public at large. Electronic media must cover the news on the TV channels to promote awareness.
	Deptt. of Fire & Safety Engineering, Educational Academy	
29	Stakeholder/ Deptt. of fire & safety Engineering educational institute/ academy	With the help of Deputy Director, Industrial Health & safety will conduct the complete off-site mock drill operation.
	Petroleum & Industries	
30	Depot Manager, IOC Depot Transport Manager, IOC depot	Will act as an emergency controller and will implement all the provisions of On-Site Emergency Plans to conduct this mock drill with the help of trained and expert team of sub-ordinates. Should immediately evacuate all the vehicles from the depot to the parking area.

	Designation & Mobile no.	Responsibility/ Functions
31	Depot Manager, BPCL Depot Manager HPCL Depot Manager BPCL terminal Manager, HP Bottling plant	Will immediately rush with subordinates taking fire-fighting equipments on receipt of mutual-help call from the IOC. BPCL fire fighting team will also operate their system of fire hydrant and provide cooling of Indian Oil tanks from the premises so that fire should not spread. All Oil company's senior people will work as expert team to meet the challenge of incident created by earthquake.
Civil Defence & Home Guard, Primary Health Centre		
32	Commandant, Home Guard	Cordon of the area and help the local police in the evacuation and maintaining peace and harmony.
33	In-charge, Primary Health Center	Small-injured persons will be treated at the Primary Health Center.
Public Works Department/ PTS/APTC/BSF		
34	Executive Engineer, PWD NH	Management of drainage system during and after the mock drill.
35	Police Training School Border Security Force	Provide peace and harmony in coordination with police.
Food & Civil Supply Department/ Telecommunication Department & NGOs		
36	Food &Civil Supply Department	Supply of food, medicines, tents etc at shelter place.
37	Telecommunication Department	To monitor that the emergency telephones of IOC, other Oil depots and Crisis management agencies remain operating during the incident.
38	Medical Institute & NGOs	Shelter home arrangement

(B) Expert Meeting at IOC: Experts discussed on the evaluation format, designated expert Observers at different places like evacuation and at rescue operation from building & from near by areas. Tasks were divided among the members. Complete review visit was made of the IOC campus & its neighbors. Review of availability of water and foam for extinguishing fire created by earthquake. Parking area for the fire tenders, govt. and private vehicles and of removal of oil tankers at emergency operation in drill.

In this meeting IOC depot senior staff, Department of Industrial Health and safety, Project Officer Disaster Risk Management-UNDP, Doctors, Fire & safety Engineering department, Engineers from the Technical Institute, HPCL Bottling plant, IOC Security Guard, In-charge Police Station, Staff of Health Centre participated.

(C) Mutual Aid meeting at IOC: The Local Crisis Group members discuss on the preparedness of Disaster control management plan as advised by District Magistrate. Have exchanged the availability of various fire fighting and safety equipments viz. Fire Hoses, DCP fire extinguishers, PPE, Foam (AFFF) etc possessed by them. Visited site and methodology was prepared to cope up the scenario of Earthquake. The mutual aid members especially BPC depot which is just adjoining to the affected site, should be prepared to cool IOC tanks with their hydrant network and also to provide the foam connection. Hydrant line of all three depots of IOC, BPC & HPC is interconnected and to be hooked up if required. Sr. depot manager has to brief about the chain of events, which is planned for the mock- drill.

(D) Field Visits: To major individual governmental departments and NGOs of the district for discussion on the mock drill and to see the preparation like at Hospital (Infrastructure, Ambulance etc), Airport & its fire brigade, Municipal corporation, Fire Brigade, Police station, B.S.F., Civil Defence & Home Guard, Railway station etc. Early discussion on Incident Command System and precautionary measures taken for the mock drill.

(E) IEC leaflets and information pamphlet are distributed among the public to avoid panicky among the public:

IEC materials:

- Bhukamp Margdharshika (Do's & Don'ts)
- Suraksha Margdharshika

Information pamphlet for the public:

- Information on Earthquake Off-site Emergency mock drill pamphlet distributed well in advance at nearby locations.

(F) Finally implementation of Off-site Emergency Mock drill on the date.

IOC depot as per their On-site emergency plan started the fire fighting operation and informed all the mutual-aid partners M/s HPCL, BPCL, HP Bottling plant, BPCL terminal. Even then fire was not controlled they have called the meeting of Expert group under the chairmanship of local crisis group and declared Off-

site emergency accordingly siren was blown and Chairman of District Crisis management & Police with Fire and Municipality were informed, in-turn Collector (Chairman of District Crisis management group) called all the stakeholders with there team and equipments to control the emergency. Police fire brigade and Municipality water tank arrived in given schedule response time and started operation at the tank area and cooling of all near by tanks. They have used foam tender at the place of oil fire and cooled the near by tanks. About 50 people are affected and many are captured in the IOC administrative block, near petrol tank and at slums. Therefore, a state of emergency was declared and rescue, evacuation and fire-fighting operation started.

Within minutes, District Crisis Chairman reached to the incident and started monitoring the off-site emergency operation such as fire fighting, rescue operation, evacuation of the nearby colonies to shelter home, maintaining law & order, controlling traffic movement and injured persons. Victims were sent to various hospitals in ambulances on giving priority to human life.

IOC depot in-charge found, big cracks in the building of administrative block and informed the Collector about the 20-30 people trapped in damaged building are to be rescued by Civil Defence, Home Guard and Police fire brigade. A rescue operation was carried at Earthquake damaged buildings were 25 people were trapped, rescued by ropes, ladders by home guard & Civil Defence team.

It was reported by the security-in-charge that outside depot one of the parked tanker caught fire, which could have dangerous because petrol tankers are parked in the near by parking area, which were removed one by one in emergency to the traffic-free road and fire was controlled by DCP (Dry Chemical Powder) cylinder and foam by the police fire brigade team. The traffic police at the National Highway controlled traffic.

IOC Gate lot of relatives approached and created lot of noise to find out details about their family members working in the IOC depot. They were worried because of this Earthquake disaster, that their family member should not have victim in this incident. The main gate was very well managed by one of the Mutual aid partner from HP bottling plant and person from the Collectorate.

Railway Track was kept clear for the movement of emergency vehicles and station manager having information about the incident has controlled all the movement of trains on the track behind IOC, BPCL and HPCL depot.

Shelter Home was identified and three hundred people were shifted and necessary arrangement for their proper stay arrangements were made and they were supplied medical aid, food, drinking water. A team of Doctors, Nurses was available at the shelter home that has attended the victims and serious

patients. District Collector has visited the shelter home to evaluate the facilities of medical aid, food, shelter and drinking water etc.

Operation Path Finder- Sequence of events

Time	Event	Action by
11:30 AM	Petrol leakage due to earthquake on tilting of the tank and damage in the administrative block.	Indian Oil Depot
11:35 AM	Expert meeting to handle the incident	IOC expert team
11:38 AM	IOC fire brigade team and expert team moved at the site and started decanting the tilted tank, meanwhile due to thunder lighting leaked petrol caught fire.	IOC fire brigade
11:40 AM	Call for the mutual aid, IOC team started fire-fighting operation but found difficult to control	Indian Oil Depot
11:45 AM	Information to Collector, ADM, SDO & SDM, SP office, Director IH & Safety, Private Hospital, Govt. Hospital, Pollution Board, Dog squad, Municipality, Traffic, Police Station, Railways, Airport, Public Relation Department, PWD etc.	IOC
11:47 AM	Call expert meeting of mutual aid members	IOC & Mutual Aid
11:48 AM	The person was designated for the drill	IOC
11:50 AM	Communication in charge informed expert group	Communication
11:52 AM	Expert group reviewed the situation	Expert group
11:52 AM	Expert group reviewed the situation with LCG	Expert group & LCG
11:53 AM	Decided to inform DCG for Off-site Emergency	LCG
11:54 AM	Off-site siren was blown	IOC
11:55 AM	LCG informed to DCG for Declaration of Offsite Emergency	LCG & DCG
11:55 AM	Communication In charge informed all group of LCG regarding emergency	Communication
11:56 AM	LCG Leader informed their worker leader to start their work	LCG
11:58 AM	Head of all groups start for LCG control room and depute their representatives at designated place for continuous monitoring and review.	IOC

Time	Event	Action by
12:00 PM	As per the opinion of expert group affected area was 1/2 Km	Expert group
12:05 PM	LCG informed to transportation & rehabilitation team to keep themselves ready at LCG control room. Also informed transportation in charge to send Bus at LCG control room.	LCG
12:10 PM	LCG inform DCG Chairman no improvement	LCG & DCG
12:12 PM	Each person entered in the affected area switched off his/her mobile	IOC
12:14 PM	Expert group informed for additional resources requirement viz. Ambulance, Fire tender, Transport arrangement and rehabilitation.	Expert group
12:15 PM	Police took over NH and cordon off and helped in evacuation & traffic control	Police
12:15 PM	Fire fighting team & rescue team started monitoring	Fire & Civil Defence
12:16 PM	20-30 persons found trapped in damaged building	IOC
12:18 PM	5 people burn with minor burns have been provided first aid treatment at OHC	IOC & Ambulance
12:20 PM	Police informed LCG control room for the trapped persons	Police
12:24 PM	Out of nine-affected persons 2 badly injured shifted after first aid to metro city by Air. Three person injured have been sent to Govt. Hospital by ambulance other four shifted to Private Hospital for treatment.	Ambulance
12:25 PM	Police announced with public address system regarding incident in the surrounding area.	Police
12:26 PM	Transportation in charge & Police arranged buses for evacuation of affected areas	Police & Transportation
12:26 PM to 12: 56 PM	IOC, Mutual Aid members, LCG & DCG member fight for mitigation of the incident	Crisis group
12:30 PM	Civil Defence and Home Guard carried rescue operation in damaged building by rope rescue and ladder rescue. Fire brigade police rescued the people who are trapped in the fire	Civil Defence and Home Guard
12:36 PM	Affected persons rushed at Shelter home	Shelter home

Time	Event	Action by
12:40 PM	Pollution control personnel informed to LCG & DCG for situation under control for toxicity monitoring.	Pollution board
12:45 PM	Outside the IOC main gate fire at petrol tanker was reported, which was controlled by police fire brigade with use of foam & DCP.	Fire brigade
12:50 PM	Expert group verified regarding situation under control	Expert group
12:53 PM	Expert group informed to Chairman LCG	Expert group & LCG
12:55 PM	Chairman LCG informed Chairman of DCG	LCG & DCG
12:56 PM	Chairman DCG declares **"ALL CLEAR"** Off-Site Emergency is over	DCG
12:58 PM	**"ALL CLEAR SIREN"** blown	DCG
01:15 PM to 01:50 PM	All the observers and members of the committee LCG, DCG reviewed the performance of Off-Site Emergency Mock Drill. Each department schedule, performances are reviewed by Chairman DCG and he made recommendations.	Participants in Mock drill

(G) Review meeting at IOC depot after the mock drill:

After the Earthquake Emergency Mock drill, District Crisis Chairman (Collector) convened the performance review and taken the report.

Observers:

i) At Incident site:

- On melting of hydrant pipeline it could not be used, hence isolating the burnt part the rest part could be used for cooling & extinguishing fire with foam. The Foam contains 5% foam and 95% water.
- Monitors should be placed at every oil depot for making pressure of water and foam to reach the fire.

ii) At Control room:

- IOC must make a control room from where all the operation in the plant area could be noticed.
- Requirement of a device to SMS the entire District Crisis Group at a time.
- Responsibility shall be taken with ownership.

iii) At Main gate:

- People were appreciating the drill and no panicky as they were informed by distribution of pamphlets. Role-play was seen in some places.

iv) At Traffic:

- Vehicle from Food & Civil Department etc were stopped by traffic on not having any identification on their vehicle moving for the relief work in incident area.
- Municipality rescue team came early.

v) At Shelter & Evacuation:

- Medical aid, food, water and trauma counseling were provided.
- About 300 people were rescued from the incident place.
- Requirement of more shelter home was observed.

Findings, suggestions in re-view meeting & Conclusion:

1) Response time which is most important in case of Disaster in saving life & property was discussed and it was reported that all the stakeholders of the disaster management have reported in time except Airport fire brigade and ambulance reported half an hour late as they were to attend one plane landing at the airport.

2) Water supply by Municipal Corporation was very well managed and reached on time.

3) All IOC depot fire protection installation found working very efficiently even mutual aid partners has supported fire-fighting operation from their premises to the IOC premises.

4) Police fire extinguisher were well planned and they have utilized their two foam tenders at the petrol fire tank, other two tankers were put to use for cooling the other tank which is effective way of fire fighting.

5) Electricity Board had played a very important role for cutting the power supply of 33 KVA line of that incident area. Collector instructed to cut the line of the incident area and to make sure to provide electricity in shelter home.

6) SDO highlighted on the requirement of more shelter home for the large population, on this Collector said, Mandi has several-covered places, it could be used for making two shelter homes.

7) Shelter home at Medical Institute reported about 300 persons were bought to shelter home which includes children, ladies, gents, disabled and

injured persons. He has also reported five serious patients referred to Govt. Hospital after first aid. Six injured persons were admitted in the general ward. They have provided the food; drinking water and required medical help.

8) Chief Medical Officer highlighted on the shortage of Staff Nurses. It was instructed to arrange Blood and appropriate number of Doctors at the place of the incident.

9) Civil Defence & Home Guard has requested for additional rescue equipments for which Collector has asked to provide the list of the equipments to ADM.

10) District Collector instructed Civil Defence & Home Guard personnel to form ward level Civil Defence Committee.

11) Police arrangement was very well appreciated in managing the evacuation and timely help from local police station. They have also maintained law & order situation during the period of incident.

12) Traffic police has played appreciable role in managing the traffic at National Highway in making road available for the entire emergency vehicle, ambulances and for the petrol tanker rescued from the parking site of IOC. They have also seen that general public should not be harassed in traffic clearance.

13) Police fire brigade has used water for controlling the kerosene & petroleum fire at IOC gate where as they should have started foam for extinguishing that fire. Chairman DCG highlighted this, emphasized on finding the type of fire.

14) All Oil companies asked to get connected through wireless line with Control Room Police.

15) Oil companies were instructed to inform District Crisis Management team on first report of the incident and make arrangements of foam, equipments etc from mutual aid companies to fight similar kind of Disaster.

16) IOC made appeal that in the boundary wall of the depot public have made houses and are cooking food, out of which any time fire may come to the petrol tanker and may cause big fire, on this Collector instructed ADM to take appropriate action. They also requested to provide parking place for the tankers standing outside the gate on road, on this it was instructed to make survey and provide information so that land may be procured.

17) NGOs role were very well appreciated particularly in case of the Department of Fire & safety, Educational Institute.

18) Deputy Director, Industrial Health & safety have said this type of mock drill must be conducted at all hazardous place at regular interval. So that public at large can be educated what to do during disaster.

19) Project Officer, Disaster Risk Management, UNDP have said this type of Emergency situation in future should be carried more efficiently in coordination with public. The construction of petrol tank and buildings shall be earthquake resistant. Plan should be updated regularly.

Summary & Conclusion:

This paper attempted to develop the evaluation of Standard Operating Procedure of the Emergency Response Plan. Evaluation of the coordination among various Emergency Support Functionaries. Practicing the Incident Command System of response. Building of team spirit among public-private stakeholders at various levels while working together to face disaster.

Acknowledgement:

The evaluation study on emergency response plan was supported by District Crisis Group, Indore and the local stakeholders & guidance from Headquarter, UNDP.

Reference:

I. GOI 2005. Disaster Management Act of India. Ministry of Home Affairs, Government of India, New Delhi.

II. NDMA, GOI. July 2007. Preparation of State Disaster Management Plans, National Disaster Management Guidelines

III. GOI-UNDP Disaster Risk Management Programme. 2002-2007. New Delhi, India: United Nations Development Programme; 2002. UNDP. A Compendium on Disaster Risk Management: India's Perspective – A Premier for Legislators.

IV. GOI. 2004. Disaster Management in India- A Status Report. Government of India, Ministry of Home Affairs. National Disaster Management Division, New Delhi. India.

V. Pathak A. A Brief Case study of the Earthquake Disaster in Gujarat. The World Bank Institute (WBI) & National Institute of Disaster Management (NIDM) 2007.

VI. Case Study: Gujarat Earthquake 2001 Bhuj Earthquake: Preliminary Report from IIT Kanpur.

VII. Benchmarks, Standards and Indicators for Emergency Preparedness and Response, Emergency and Humanitarian Action. New Delhi: WHO South-East Asia Regional Office; 2007.

VIII. Public Health Emergency Preparedness, U.S. Department of Health & Human Services https://archive.ahrq.gov/research/hospdrills/introduction.htm.

IX. Satapathy S., Walia A. Affected Parents and Other Stakeholders of a Fire Disaster Management in India: A Situational Analysis.

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16/17 June 2013 disaster of Uttarakhand, India and lessons learnt

Piyoosh Rautela

Abstract

Early arrival of monsoon, its collision with westerlies, ensuing abnormally high precipitation, resultant fast melting of fresh snow accompanied by breach of a glacial lake, Chorabari Tal; stage was thus set for a major hydro-meteorological disaster in Uttarakhand in June 2013. With no specific warning a disaster of this magnitude was not anticipated and everyone was taken by surprise. The incidence coincided with the peak of the tourist season when pilgrims, tourists and others from across the country and abroad had gathered in the disaster-affected region in large numbers. The incidence thus resulted in a major tragedy of recent times in which human death toll surpassed 4000. The disaster was a major setback for the economy of the state to which tourism and pilgrimage contribute a major chunk. Burden on public exchequer was further exacerbated by tax waiver and assistance provided to disaster-affected population even on losses that are not generally covered by State Disaster Response Fund. Important lessons were however learnt in managing this disaster and these would go a long way in strengthening the disaster management system not only in Uttarakhand but also elsewhere.

Keywords: *Uttarakhand • Kedarnath •Mandakini • Higher Himalaya •Monsoon • Landslide • Toe erosion • Flash flood • Glacial lake outburst.*

Introduction

Even after more than three years what exactly transpired in Uttarakhand, particularly in Kedarnath area on 16/17 June 2013 remains to be convincingly settled and hypothesis of various sorts are often put forth and keenly debated even today, not only by scientists and researchers but also by environmentalists, media personnel and masses (Dobhal et al., 2013; Rana et al., 2013; Rautela, 2013; Uttarakhand Flood Disaster, 2013; Bandyopadhyay and Sekhar, 2014; Chopra, 2014; Dube et al., 2014; Expert Committee Report, 2014; Kotal et al., 2014; Allen et al., 2015; Chattoraj and Champatiray 2015; Singh et al., 2015).

Environmentalists often attribute this tragedy to anthropogenic interventions; particularly hydropower projects (Uttarakhand Flood Disaster, 2013; Chopra, 2014; Expert Committee Report, 2014). The script of the disaster was however written in sparsely populated Higher Himalayan region of Uttarakhand that is bereft of anthropogenic pressure of any sort. Moreover, Forest Conservation Act, 1980 and other related legislations prohibit human interventions in major

portion of the disaster-affected region. Despite being strategically important this region at the same time has limited road connectivity and large portion of the region remains snowbound, particularly during winters when the inhabitants of the frontier villages retreat to lower elevations.

Most people are aware of devastation in Mandakini valley, particularly Kedarnath which is attributed to high media coverage due to massive loss of human lives. Entire Higher Himalayan region of Uttarakhand from Kali river valley in the east to Yamuna river valley in the west was however devastated by this disaster and 5 of the 13 districts of the state, namely Rudraprayag, Chamoli, Uttarkashi, Bageshwar and Pithoragarh were worst hit (Fig. 1). This disaster manifested itself in the form of flashflood, landslide, debris flow and toe erosion that are owed to excessive rainfall in the Higher Himalayan region that generally receives major portion of precipitation in the form of snow.

In 2013 monsoon arrived early and there was excessively heavy rainfall right in the beginning. As per the Indian Meteorological Department (IMD) the rainfall in the state between 15 and 18 June 2013 was 385.1 mm against the normal of 71.3 mm; augmented by 440 percent. This is attributed to the confrontation of the SW monsoon front with the westerlies (IMD, 2013).

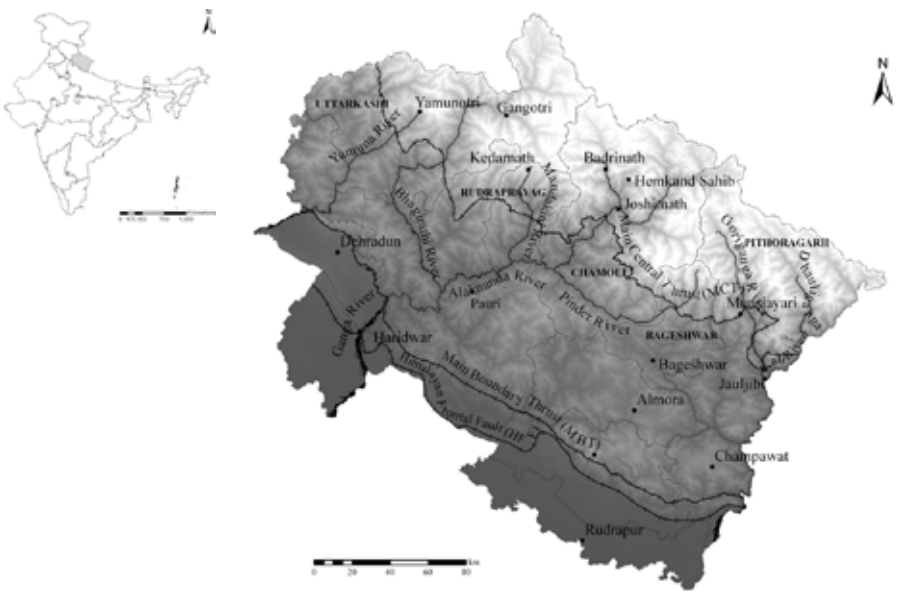

Fig. 1: Map depicting the location of the disaster affected districts of Uttarakhand

Heavy rainfall in the upper reaches resulted in water levels of all major rivers to rise and fast melting of winter snow due the impact of falling rain drops only

worsened the situation. Major devastation was largely caused by toe erosion by fast flowing debris laden mountain rivers.

Disaster affected area and its vulnerability

Major portion of the state of Uttarakhand is located in the Himalayan terrain and has altitudinal range of 200 to 7784 meters above sea level (asl). The state shares its border with Nepal in the east and Tibet (China) in the north and has 2 administrative divisions, Garhwal and Kumaun, and 13 districts. Of these 5 northern districts namely Bageshwar, Pithoragarh, Uttarkashi, Chamoli and Rudraprayag were worst affected by the disaster of 2013 (Fig. 1).

Geologically the disaster affected area falls in Lesser Himalaya, Central Crystallines and Higher Himalaya. Main Central Thrust that is a major tectonic discontinuity of the Himalaya traverses through the state along which the Central Crystallines are juxtaposed against Lesser Himalaya along a N-NE dipping tectonic discontinuity. The area has particularly high relative relief that promotes mass wastage and erosion. Except for Uttarkashi, some portion of which falls in Zone IV all the disaster affected districts fall in Zone V of Seismic Zonation Map of India (IS 1893, 2002). Geological set up, ongoing tectonic activities and high relative relief coupled with peculiar meteorological characteristics make the area vulnerable to a number of hazards of which earthquake, landslide and flash flood are common.

The disaster-affected region has a number of picturesque tourist destinations that include Joshimath, Auli, Chopta, Gopeshwar, Bageshwar, Chaukori and Munsyari. The area also houses a number of sacred shrines and pilgrimage routes. Besides Chota Kailash-Kailash-Mansarovar and Hemkund Sahib these include Chardham route leading to Badrinath, Kedarnath, Gangotri and Yamunotri that is the biggest and most cherished Hindu pilgrimage circuit of the country (Fig. 1). Being located in Higher Himalaya the duration of the Chardham pilgrimage is restricted between June and November; exact dates of opening and closing of the sacred shrines are decided according to Hindu tradition. People from across the country and abroad thus visit the area in large numbers. Tourism and pilgrimage are thus a major source of income for the people of the area as also for the state.

This region is also source to major glacier-fed Himalayan rivers that include Alaknanda, Bhagirathi, Mandakini, Yamuna, Kali, Dhauli and Pinder. Alaknanda and Bhagirathi confluence at Devprayag and thereafter the river is known as Ganga. Mandakini valley of Rudraprayag district that was hit the hardest by the disaster of June 2013 houses sacred Hindu shrine of Kedarnath that is dedicated to lord Shiva, the God of death and destruction. The temple township (Fig. 2) is located on glacial outwash deposits at an altitude of 3581 meters asl. For

reaching Kedarnath one had to trek upstream along the course of Mandakini from Gaurikund for a distance of 14 kilometers (Fig. 3).

Fig. 2: View of the temple township of Kedarnath, with camera looking east

Originating from Chorabari glacier Mandakini river forms the western boundary of the temple township while abandoned channel of Saraswati, that had confluence with Mandakini to the south of the temple forms the eastern boundary. Dudh Ganga meets Mandakini to the south of Kedarnath and thereafter till Gaurikund, Mandakini maintains a tectonically controlled NNE–SSW course (Fig. 3).

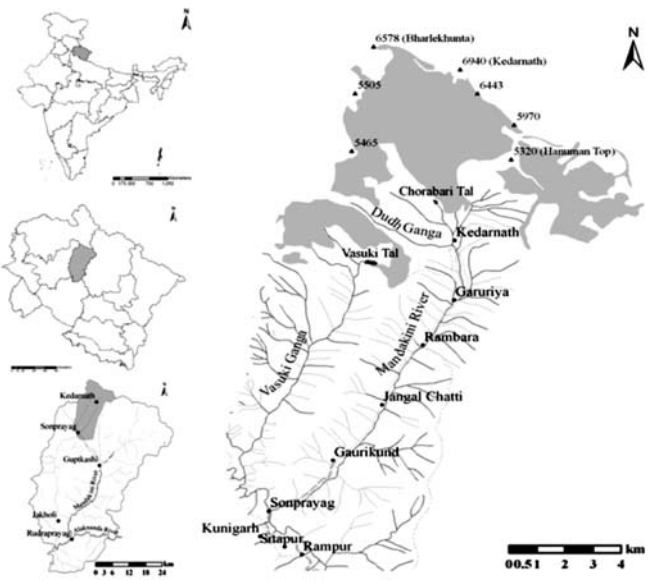

Fig. 3 Location map of Kedarnath area. To the left are maps of India, Uttarakhand and Rudraprayag district

A moraine dammed lake, Chorabari Tal, was present little downstream of the snout of Chorabari glacier. This lake was located in the depression formed in the glacial material to the west of the right lateral moraine and was fed by the seepage of the glacial melt. The lake did not have a well-defined outlet and its water used to seep out along the moraine slope to the NNW of Kedarnath. Even though the depression was around 200 meters long, 100 meters wide and 15–20 meters deep, not more than 2–3 meter water used to be there in the lake.

Table 1 Disruption of major highways due to landslides and toe erosion during the monsoon period between 2010 and 2015 (Data source: State Emergency Operations Centre, Uttarakhand)

Sl. No.	Highway	Year	Number of days when traffic was disrupted on the highway					Road disruption (in percent)
			June (30 days)	July (31 days)	August (31 days)	September (30 days)	Total (122 days)	
1.	Rishikesh – Badrinath (NH 58)	2010	1	17	25	9	52	42.6
		2011	2	13	14	10	39	32.0
		2012	2	6	18	7	33	27.1
		2013	15	20	17	13	65	53.3
		2014	1	5	4	4	14	11.5
		2015	5	15	17	0	37	30.3
		Total	**26**	**76**	**95**	**43**	**240**	**32.8**
2.	Karnaprayag – Kedarnath (NH 109)	2010	3	12	9	15	39	32.0
		2011	5	9	17	4	35	28.7
		2012	5	8	6	5	24	19.7
		2013	13	21	18	13	65	53.3
		2014	2	11	2	5	20	16.4
		2015	5	12	5	0	22	18.0
		Total	**33**	**73**	**57**	**42**	**205**	**28.0**
3.	Dharasu – Yamunotri (NH 94)	2010	0	7	40	19	66	54.1
		2011	5	5	14	12	36	29.5
		2012	4	5	16	13	38	31.2
		2013	12	20	22	18	72	59.0
		2014	1	10	4	5	20	16.4
		2015	0	4	2	0	6	4.9
		Total	**22**	**51**	**98**	**67**	**238**	**32.5**
4.	Rishikesh – Gangotri (NH 108)	2010	1	9	38	19	67	54.9
		2011	7	14	16	19	56	45.9
		2012	5	4	22	10	41	33.6
		2013	17	16	18	17	68	55.7
		2014	0	19	7	3	29	23.8
		2015	1	4	6	0	11	9.0
		Total	**31**	**66**	**107**	**68**	**272**	**37.2**

Both landslide and flash flood are common in the region during the monsoon period, rainy season over the India sub-continent, which extends between mid-June and mid-September. This period coincides with the ingress of both pilgrims and tourists in large numbers. Road connectivity in the region is often disrupted for long periods during this time due to landslides and toe erosion by the rivers (Fig. 4; Table 1). It is a cause of inconvenience, discomfort and misery for pilgrims, tourists and others who are often forced to change their travel plan. It at the same time is a major concern for the state that has to resort to extraordinary measures for evacuating the stranded people and ensuring supply of essential items in the cut off areas.

Fig. 4 View of road disruption in June, 2013 due to bank erosion in the proximity of Tawaghat, Pithoragarh (left) and debris slide in Dharali, Uttarkashi (right)

The disaster of 16 / 17 June 2013

There was heavy rainfall in the entire state with the onset of monsoon that arrived early in 2013. This is attributed to the clash of the SW monsoon front with the westerlies. Prolonged and unprecedented heavy rainfall between 14th and 18th June 2013, over a large area, resulted in flash floods and landslides at many locations, which eventually turned into a massive disaster.

Table 2 Precipitation as recorded by IMD stations in the disaster-affected areas between 14 and 18 June, 2013 (Data source: India Meteorological Department, Government of India)

Sl. No.	Location	Precipitation (in mm)				
		14 June	15 June	16 June	17 June	18 June
1.	Bhatwari	20.0	18.0	35.0	70.0	50.0
2.	Barkot	10.0	15.4	112.6	20.0	20.0
3.	Chamoli	1.0	40.0	58.0	80.0	100.0
4.	Jakholi	30.0	70.0	121.0	110.0	70.0
5.	Joshimath	0.0	31.4	41.9	113.8	80.0
6.	Karnaprayag	8.2	7.0	88.0	90.0	82.3
7.	Munsyari	4.0	25.0	44.0	85.0	75.0

Sl. No.	Location	Precipitation (in mm)				
		14 June	15 June	16 June	17 June	18 June
8.	Pithoragarh	0.0	0.0	11.2	90.0	120.0
9.	Purola	30.0	40.0	170.0	60.0	104.0
10.	Rudraprayag	4.0	11.8	89.4	92.2	59.2
11.	Tharali	0.0	15.0	58.0	173.0	80.0
12.	Uttarkashi	15.0	50.0	130.0	162.0	19.0

The rainfall in the state between 15th and 18th June 2013 is measured to be 385.1 mm against the normal of 71.3 mm, which is in excess by 440 percent. In the period of 5 days between 14th and 18th June, the state received approximately 2000 mm of rainfall, which is more than what it receives during the entire monsoon period (Table 2). Percent deviation in rainfall clearly shows that the rainfall during the week ending on 12th June (6th to 12th June 2013) was more than 100 percent in all the districts except Pithoragarh. The rainfall however increased enormously in the subsequent week when it was measured to be 997 percent higher than normal over the state. Except for Pithoragarh and Rudraprayag deviation from normal in other three districts was more than 1000 percent in the week ending on 19th June (Table 3).

Table 3 Weekly percentage deviation of actual rainfall from normal in the disaster affected districts of Uttarakhand in June – July 2013 (Data source: India Meteorological Department, Government of India)

Sl. No.	District	Percent deviation in rainfall in the week ending on						
		12 June	19 June	26 June	3 July	10 July	17 July	24 July
1.	Bageshwar	137	1387	- 58	59	127	- 45	- 22
2.	Chamoli	185	1302	111	37	187	96	96
3.	Pithoragarh	13	238	- 41	- 50	- 4	49	- 10
4.	Rudraprayag	213	580	74	- 35	- 21	- 51	16
5.	Uttarkashi	112	1356	- 1	- 12	- 22	- 12	24

Fast melting of fresh show due to rainfall impact added to the discharge of the streams and rivers that crossed the danger level. The level of Mandakini at Rudraprayag was 7.5 meters above the danger level on 18th June 2013 and around this time most rivers in the region were flowing well above their normal levels (Fig. 5). Gushing debris laden water through the high-gradient mountain streams thus breached the banks and washed off roads, bridges, habitations and other infrastructure on their way.

Devastation was particularly severe in the Mandakini valley, particularly in Kedarnath-Rambara-Gaurikund area. This is attributed to the breach of

Chorabari Tal that had accumulated enough water to force the moraine barrier to give way (Dobhal et al., 2013, Rautela, 2013).

Fig. 5 View of the motor bridge over Alaknanda at Rudraprayag in April, 2013 (left) and on 17 June, 2013 (right) with camera looking NNW

Late in the evening of 16th June 2013 debris brought down by Dudh Ganga blocked Mandakini river in the proximity of Kedarnath. The embankment on the left bank of the Mandakini soon gave way and the abandoned channel of Saraswati to the east of Kedarnath became active. This resulted in washing off of some people in the evening of 16th June 2013 from Kedarnath, that thus became water locked. Sankaracharya Samadhi, Jal Nigam guest house and Bharat Seva Sangh Ashram were also washed off in this event. Rising level of the landslide dammed lake forced the barrier to give way and the ensuing floods late in the evening of 16th June 2013 completely washed off Rambara and devastated Gaurikund. All connectivity with the area was thus snapped (Rautela 2013).

Persistent heavy rains caused the level of water in Chorabari Tal to rise continuously. With the recession of the glacier the lake had a weak moraine barrier that could not withstand mounting hydrostatic pressure. Stage was thus set for a major disaster in Kedarnath and the barrier ultimately gave way around 7 AM on 17th June 2013. The volume of water was enormous and it carried with it huge glacial boulders and outwash material that choked the course of Mandakini and the flow of water and debris got diverted towards the temple township that was thus ravaged (Fig. 6).

There was absolutely no warning and most people were taken by surprise and had no time to respond. Besides Kedarnath this event caused devastation in Gaurikund, Sonprayag and other places.

Fig. 6: View of the Kedarnath township ravaged by the flood of June, 2013 with camera looking south

Human congregation in Kedarnath

Higher Himalayan shrines of Uttarakhand witness high influx of devotees in the beginning of the pilgrimage season due to (i) pleasant weather conditions, (ii) less of rains and road disruptions and (iii) summer vacations in schools and collages. Pilgrimage was late to start in 2013 and Kedarnath and Badrinath shrines opened to public on 14th and 16th May respectively while Gangotri and Yamunotri both opened on 13th May. This delay of almost a fortnight resulted in congregation of large number of people who wanted to finish the pilgrimage before the onset of rains.

The number of people that had gathered in the Gaurikund–Rambara-Kedarnath area when the disaster took place on 16/17 June 2013 was unusually high by all standards. Due to Uttarakhand High Court order on the issue of sanitation on pedestrian route to Kedarnath movement of horses and mules was temporarily suspended in 2013. This slowed the pace of movement and people who could have easily travelled back to Gaurikund on mule or horse back were forced to stay overnight at Kedarnath or Rambara.

Moreover routine helicopter service from Guptakashi to Kedarnath was suspended a couple of days before the disaster due to continuous rainfall resulting in poor visibility. The ones intending to travel by air thus had no option but to travel on foot and stay overnight at Kedarnath or Rambara.

Apart from this continuous heavy rainfall severely slowed down the pace of movement and many people were forced to change their travel plan and stay overnight at Kedranath or Rambara.

It was the peak pilgrimage season and Gaurikund–Rambara–Kedarnath area was highly overcrowded. With no provision of registration in place at that time no one really has an idea as to how many people were actually there in this stretch when the disaster struck.

Losses

Landslides, flash flood and toes erosion induced by incessant heavy rainfall in the Higher Himalayan region led to massive loss of human lives, infrastructure and property. The details of the same are summarized in Table 4. It is to be noticed that apart from loss of human lives other losses in the disaster-affected districts are comparable. It is due to the loss of human lives in Mandakini valley that most people consider 2013 disaster to be restricted to Rudraprayag district.

Table 4 District wise losses incurred in the state due to the disaster of June 2013 (Data source: State Emergency Operations Centre, Uttarakhand)

Head	Rudraprayag	Chamoli	Utarkashi	Pithoragarh	Bageshwar	Total
Persons dead	30	33	14	19	4	100
Persons missing	3998	0	0	21	0	4019
Persons injured	71	31	29	49	3	183
Farm animals lost	2771	1119	474	5263	665	10292
Fully damaged houses	445	566	249	702	25	1985
Severely damaged houses	374	647	527	340	130	2018
Partially damaged houses	905	2188	1967	397	133	5590
Silted agriculture land (in hectares)	1	379	341	12	8	741
Agricultural land lost (in hectares)	4279	242	339	5575	234	10669
Crop loss (in hectares)	8	245	103	113	28	497

Besides direct losses and cost of search, rescue and evacuation the state incurred heavy loss of revenue due to the disaster. Economy of the state is highly dependent upon pilgrimage and tourism and there was steep decline in the number of people visiting the state on the aftermath of the disaster (Table 5). Resumption of normal pilgrim and tourist inflow is sure to take some time and this would require dedicated effort to convince the potential visitors that Uttarakhand is safe to visit.

On the aftermath of the disaster the state waived off tax dues, particularly on tourism, hospitality and transport industry. Electricity and water dues of the masses in the disaster-affected area were also waived off. Moreover in view of severity of the disaster impact the state extended relief on items that are not generally covered by State Disaster Response Fund (SDRF). The quantum

of admissible relief was also increased by many times. In order to help them sustain during this crisis relief was also provided to commercial enterprises that are not generally covered by SDRF norms.

Table 5 Pilgrim footfall over major shrines in the disaster affected area in the period 2011–14 (Data source: Uttarakhand Tourism Development Board, Uttarakhand)

Name of place	Month	Number of pilgrims				
		2011	2012	2013	2014	Average fall in percentage in the year 2014
Badrinath	May	225558	4138812	238116	53798	96.5
	June	398260	358662	251808	42676	87.3
	July	43952	55383	-	7560	77.2
	August	48473	43366	-	3368	89.0
	September	132794	54916	-	17070	72.7
Kedarnath	May	245821	298182	149689	13823	94.0
	June	249386	196830	182551	14091	93.3
	July	29216	27712	-	3041	84.0
	August	11759	11496	-	944	87.8
	September	20746	12823	-	3796	66.1
Gangotri	May	146870	195618	105617	20193	86.5
	June	233190	175272	104136	15656	90.8
	July	57355	40124	-	6857	78.9
	August	9229	416	-	675	79.0
	September	21843	3970	-	3337	61.2
Yamunotri	May	170126	206545	115786	15316	90.7
	June	196833	142182	136997	13709	91.4
	July	44864	34312	-	3725	85.9
	August	16396	1001	-	612	89.4
	September	32083	5231	-	2393	80.8
Hemkund Shahib	May	-	-	12430	4071	1.7
	June	257133	178049	61867	19466	88.3
	July	137253	57879	-	6907	89.4
	August	92653	27658	-	2213	94.5
	September	40430	29175	1753	3075	87.1
Total		**2862223**	**6295614**	**1360750**	**278372**	**92.1**

Aftermath of the disaster

Though there was general forecast of heavy rains over the entire state none had expected such a large area to be affected in one go. Communication was hit hard and there was literal information vacuum and no one had the slightest clue as to what had transpired. This caused confusion and delayed response and resource mobilization, particularly in the initial phase. There was severe disruption of surface transport network and almost all the major highways of the state were blocked due to landslides and washing away of roads. More than 150000 persons were thus stranded at various places across the state.

Magnitude of human loss together with large number of persons stranded at various places in Mandakini and Alaknanda valleys; particularly at Kedarnath, Bhimbali, Gaurikund, Hemkund Sahib, Ghagharia, Govindghat and Badrinath resulted in high media attention in these areas. Relief and rescue efforts were thus focused on these areas. Concentration of aerial rescue operations facilitated easy entry of media personnel even to the remotest areas. This in turn encouraged media to focus attention on this very region. All rescue and relief efforts were thus initially focused on Mandakini and Alaknanda valleys and the people in the other disaster-affected regions of the state could not get immediate and adequate attention.

All communication links with Mandakini valley were snapped in the evening of 16th June 2013. Adverse weather and terrain conditions did not provide opportunity of resorting to alternative probes. The outside world as also the district administration therefore remained unaware of the events in Mandakini valley till 18th June 2013.

With improved weather and visibility aerial rescue operations were initiated in early hours of 18th June 2013 and 2007 persons were evacuated on the same day from Kedarnath. Realising the constraints being faced in aerial rescue operations 69 permanent and temporary helipads were quickly activated across the state and besides 17 civilian choppers hired by the state government 54 Indian Air Force (IAF) choppers and fixed wing crafts, 7 Army Aviation choppers and 4 choppers of other states were pressed into service (Fig. 7). Due to limited stock of aviation turbine fuel (ATF) in the disaster affected area and inability to immediately move in bowsers due to road disruption precious time was however lost in refueling. Despite constrains of various sorts more than 39165 persons were evacuated by air alone and this proved out to be the biggest aerial evacuation ever attempted.

Fig. 7 View of the aerial evacuation of pilgrims stranded on Rambara - Kedarnath track by Indian Air Force

Ground search and rescue operations were slightly delayed due to washing off of motor roads as also pedestrian track leading to Kedarnath and Hemkund Sahib at many places. Despite best efforts and intentions terrain conditions made it difficult even to airdrop food and water at many locations and this added to the sufferings and trauma of the affected persons. Besides civil administration and state Police National Disaster Response Force (NDRF), Indo – Tibetan Border Police (ITBP), IAF, Indian Army and Indian Navy joined rescue operations.

The evacuated persons from Mandakini, Alaknanda and Bhagirathi valleys were first brought to then operational road head at Guptakashi, Joshimath and Chinyalisaur respectively. 586 buses and 1440 taxies were requisitioned for evacuation and 71 relief camps were organised across the state that catered to food, shelter, medical and other needs of 151629 persons for different durations.

Large number of evacuees had lost all their belongings and did not have resources to manage their journey back home. Arrangements were therefore made for the return journey of the evacuated persons who were also provided cash assistance to cover their in-journey expenses.

Despite best efforts evacuation could only be completed on 23 June 2013. Rescue operations were however not risk free and 4 choppers crashed during rescue operations. 48 persons engaged in rescue operations including 5 of IAF, 9 of NDRF, 6 of ITBP and 28 of State Police, Administration, Forest and Civil Aviation lost their lives while engaged in rescue operations.

Lessons learnt

Every disaster exposes the shortcomings of the system and highlights key elements of the vulnerability of the affected community. It thus provides an opportunity to plug the holes and be better prepared for the next disaster. Sharing of these experiences is vital as taking lead from these effective and context specific measures can be planned and implemented for strengthening resilience and avoiding disaster induced loss, misery and panic. Issues related to the same are discussed in the sections below.

Telecommunication: All communication links with the disaster-affected area, particularly in the Mandakini valley, were disrupted in the evening of 16th June 2016. The last received message from Gaurikund-Rambara-Kedarnath area was hurriedly communicated through Police wireless network at Rambara before its being washed off. It certainly indicated an emergency situation but what exactly had transpired could not be fully comprehended from it. Mobile towers in the area also became dysfunctional soon due to electricity disruption, shortage of fuel to run the generators and other technical snags. Moreover batteries of most mobile phones were drained off while still trying to search the network.

Communication having been disrupted there was no information coming to State Emergency Operations Centre (SEOC) from the disaster-affected area. Besides delaying response this added to the confusion as different versions started being aired by the media due to lack of authentic information.

Steady inflow of updated, authentic and reliable information is vital to effective management of any disaster. There thus has to be a mechanism for ensuring regular inflow of updated information from the disaster-affected area under all circumstances. The communication system should therefore be robust and reliable with at least triple redundancy so as to ensure functional alternative communication under all circumstances.

Disruption of communication at the same time adds to panic and trauma of disaster-affected people and therefore alternative power arrangements have to be put in place for running mobile towers. The mobile service providers should therefore be persuaded to maintain adequate stock of fuel to operate the generators and install solar power back up facility, particularly in the remote and disaster prone areas. Solar powered mobile recharging facilities should at the same time be created, particularly in areas that are visited by people in large numbers. At the same time people venturing to these areas should be educated on ways of delaying discharge of mobile battery through awareness campaigns.

Though facing information blackout SEOC was flooded with requests for updated information from officials, media and next of kin of the persons who had come over to Uttarakhand. To cope up with this situation a number of new telephone

lines were hurriedly activated at the SEOC. Many telephone numbers, including some personal mobile numbers of the officials, thus got circulated through various modes and this amounted to confusion.

SEOC should therefore have a single telephone number with multiple lines and with capability of being upscaled during major disaster incidences. Dedicated four-digit toll-free number of SEOC (1070) should be utilised for this purpose. For the convenience of the masses this number should be publicized through various modes. Use of one number would be convenient for all concerned. Mobile numbers of disaster management officials should not be made public as this distracts their attention from other important tasks they have to handle during disaster situations.

Media briefing: Arrangements for media briefing and providing information to next of kin of disaster-affected persons were not in place. This resulted in overcrowding at the SEOC and often disrupted its routine functioning.

After any disaster media personnel are under immense pressure to report the latest updates and lack of information from authentic sources often results in rumors that add to the trauma of affected population. This at the same time demoralizes the ones engaged in post–disaster operations.

Special care therefore needs to be taken for briefing of media persons at regular intervals by duly authorized persons having access to authentic and updated information. The media personnel should at the same time be provided assess to video feeds and photographs of the disaster affected area, particularly those depicting progress of rescue and relief measures. Besides satisfying the next of kin of the affected persons this would boost the morale of the persons engaged in rescue and relief operations. If possible arrangements should also be made for taking the media personnel to the disaster-affected area.

The persons involved in operations should not be overburdened with the responsibility of interacting with media. Media should at the same time be discouraged from venturing into the SEOC.

Public information: Responding to public queries, particularly from the next of kin of the persons perceived to be present in the disaster-affected area overburdened the SEOC. Large number of callers had come to know of the incidence through media and not being conversant with the geography of the state they were not sure as to which area was actually affected by the disaster and in which area their next of kin were present. Most callers were in an emotionally disturbed state and required counseling and consoling. Talking to them was no less than a trauma for people manning the SEOC. Moreover large number of callers could not communicate either in Hindi or English.

On the aftermath of any disaster it is normal for next of kin of the affected persons to seek information on the welfare and whereabouts of their loved ones. Separate arrangements have therefore to be made for responding to their queries. If possible persons with special tele-counseling and psychologically consoling skills should be engaged for this. Special care should be taken in incidences where there is possibility of linguistic differences between the potential callers and the ones responsible for responding to public queries. This becomes particularly pertinent if the disaster-affected area is routinely visited by people from other states or nations in large numbers. In such cases people conversant with the language of the potential callers should be engaged. Assistance of pre-registered volunteers could be taken for this purpose.

Information management: After a while the information being received at the SEOC from different sources became so voluminous that it became difficult to process, segregate and use it for decision making, planning and resource mobilisation. Moreover both officials and non-officials soon started to seek synthesized and specific information on various aspects of the disaster. It often became difficult to respond to their queries.

SEOC should therefore be adequately manned and have the required information handling and processing capabilities so as to ensure that the information received is quickly analysed and used for decision making, particularly relating to response and resource mobilization. The information received at SEOC has also to be segregated so as to promptly address any specific information requirement.

Relief and rescue: Though highly specialized, professionally trained and well equipped, the response forces called in for search and rescue on the aftermath of the disaster were not conversant with local terrain and weather related peculiarities. They at the same time did not have knowledge of alternative routes, locally available resources and hardships likely to be faced while undertaking rescue. Moreover induction of rescue workers in the disaster-affected area was not easy due to transport disruption coupled with bad weather conditions.

Knowledge of local ground realities is often critical to the success of search and rescue operations, particularly in the mountainous terrain. Local people therefore enjoy a distinct advantage and in almost all disaster incidences local people and other survivors are the first responders. It is therefore necessary to train local people in search and rescue and provide them required equipment so that they are better prepared to face emergency situations and help their community as also others.

The specialized response forces being raised by the states should at the same time be exposed to local ground realities through regular ground familiarization exercises. This would ensure their effectiveness in the event of a disaster.

Governance: On the aftermath of the disaster taking clue from the Comptroller and Auditor General report (CAG, 2010) the issue related to ineffectiveness of the State Disaster Management Authority (SDMA) was repeatedly highlighted by the media. Besides maligning the image of the state government it adversely affected the morale of the officials engaged in post-disaster operations.

For effective disaster governance it is therefore a must to strengthen and empower institutions responsible for disaster risk reduction; particularly SDMA, State Executive Committee (SEC) and District Disaster Management Authorities (DDMA). Most states are not paying due attention to the very fact that the Disaster Management Act, 2005 requires all executive actions to be taken either by SEC or DDMAs with SDMA being a policy making and supervising institution. Adequate attention is therefore required to strengthen and empower SEC and DDMAs in the spirit of DM Act, 2005.

Disaster management being a multi–departmental affair, coordination and unity of command are critical to the success of post–disaster response. Apart from state administration, police and different state government departments a number of other agencies were involved on the aftermath of the disaster. These included Army, IAF, NDRF, ITBP and Indian Navy. The uniformed services have their peculiar command structure and reporting procedure due to which problems were faced in information exchange and coordination.

SOPs and protocols pertaining to command structure, reporting formats, procedures and information exchange have to be therefore laid down, circulated and rehearsed well in advance to rule out possibility of lapses and confusion on the aftermath of any disaster.

Registration of tourists/pilgrims: Estimating the number of persons involved in the disaster of June 2013 was a major challenge and there were varying claims from various quarters that added to the confusion. It is therefore required that the pilgrimage be regulated and persons be registered. Besides keeping track of exact number of visitors this would help in communicating with them in case of any exigency.

It however needs to be appreciated that the pilgrimage circuit of the state has its peculiarities; (i) there is no single entry point and one can access the circuit from a number of entry points, and (ii) there are habitations all along the route till the very end and local people travel through the circuit in large numbers which makes differentiation of pilgrims and tourists difficult and registration challenging. It might therefore be hard to totally regulate the entire pilgrimage but adequate registration and other measures have to be necessarily implemented in areas where people have to trek; Kedarnath, Gomukh, Hemkund Sahib, Yamunotri and Chota Kailash-Kailash-Mansarovar. In these areas only a specified number

of persons should be allowed beyond the last road head at Gaurikund, Gangotri, Govindghat, Janki Chatti and Tawaghat after duly registering their details.

People visiting high altitude shrines have often been facing health related emergencies and a number of people, particularly on Gaurikund-Kedarnath trek, die every year due to various ailments. Health check up should therefore be made mandatory for all persons wishing to venture in these areas and only physically fit should be allowed. These persons should also be briefed on the terrain and weather conditions together with other associated hazards that the terrain might offer.

Support for evacuees: Large number of disaster-affected persons had lost all their belongings and had no resources to manage their journey back home. Having come over from long distances these people at the same time had no acquaintances around to look for help. Standard relief guidelines issued by Ministry of Home Affairs, Government of India has no mention of such situations.

In view of special circumstances the state government made arrangements for the return journey of the evacuated persons and also provided special cash assistance for covering en route expenses. It is therefore required that provision for catering to such situations be standardized, particularly for areas that are routinely visited by people from far and wide in large numbers. This would ensure prompt dispatch of the disaster-affected persons to their destinations.

Surface connectivity: Blockade of motor roads due to landslide and flash flood is common in the hills. Most tourist and pilgrim destinations in the Higher Himalaya have single road connectivity and blockade of the same often results in persons being stranded in large numbers. Providing logistics support to the stranded persons and ensuring their early evacuation thus becomes a major concern of the state.

After the disaster of June 2013 more than 150000 persons were stranded at different places across the state due to road blockade caused by landslides and washing off of road stretches at many places. Despite best efforts major roads of the disaster affected area could only be opened for light vehicles in September–October 2013. Large number of stranded persons had to be therefore evacuated by air. Constrains put forth by availability of airspace, helipads, refueling and weather conditions thus delayed evacuation.

It is therefore required that surface connectivity in the region be improved and alternative motor roads be planned and developed so as to ensure alternative connectivity during disaster incidences. In the disaster of 2013 most motor roads in the proximity of rivers and streams were washed off due to bank

erosion. Wherever possible the alignment of new roads should therefore be kept sufficiently away from rivers and streams.

Aerial evacuation: Due to prolonged disruption of roads aerial evacuation of the stranded pilgrims and others was the only available option. Large number of helicopters were therefore mobilised for this purpose. These however could not be optimally utilized due to the constraints put forth by limitation of airspace and helipads. Moreover adequate refueling facilities were not available in the disaster-affected area and bowsers could not be moved in immediately due to road disruption. Valuable operational time was thus lost in refueling of the choppers.

In view of the terrain conditions helipads with adequate stock of ATF should be developed in the hills at strategic locations. This would make disaster response prompt and effective. This would at the same time facilitate tourism and adventure sports that in turn would boost the economy of the region.

Linguistic issues: Apart from foreign nationals the disaster involved people from more than 23 states of India. The disaster-affected persons thus exhibited distinct linguistic diversity and large number of them could not communicate in a language that is commonly understood by the people of the state; Hindi and English. These persons generally come on pilgrimage in large groups where a few persons who can communicate in Hindi or English facilitate interaction. When dissociated from the group communication for most persons, particularly women became a big challenge. This put forth numerous problems for both rescue workers and relief providers. People responding to public queries also faced similar problems.

On the aftermath of a disaster involving people from different linguistic backgrounds, communication with disaster affected persons could became a problem. It is therefore required that the relief camps be adequately staffed with persons who are conversant with the language of the potential evacuees. For this volunteers could be registered and their services could be mustered as the requirement arises.

Missing persons: Large number of persons went missing in the disaster of June 2013. Legal procedure in India for declaring a missing person dead requires the missing person to be unheard of for a minimum period of 7 years by the ones who would normally have information on his/her whereabouts. Moreover ex-gratia relief admissible out of SDRF can only be provided to the next of kin of those deceased in the disaster incidence. The SDRF guidelines have no mention of the persons missing in disaster incidence.

Besides claiming relief the next of kin of the missing persons required death certificate for settling various familial, societal, official and legal issues. At that

time there existed no guidelines for declaring missing persons as being dead. Due to this disbursement of relief and death certificates was delayed. This added to the trauma of the family members of the missing persons. This issue could only be resolved after the Registrar General of India issued fresh guidelines on 16 August 2013 and prescribed procedure to be followed for declaring missing persons as being dead and issuing death certificates.

This arrangement however was specifically for the disaster of 2013 and cannot be applied to other disasters in future. It is therefore required that standardized guidelines and procedures be put in place for declaring persons missing in disaster incidences as being dead so that the next of kin of the deceased persons are not unnecessarily traumatized.

Evacuation: Injured, ill, elderly, women and children are generally accorded priority in evacuation and this thumb rule was followed on the aftermath of this disaster as well. This went on well till there were injured and ill around but after that people declined to be dissociated from their group.

It was soon realized that the people had come over in close knit groups to the disaster affected area from far and wide for pilgrimage and had no familiarity with the area. In many such groups only 1-2 persons could speak and understand Hindi or English and for the females taking to strangers, particularly males was taboo. Disassociation from the group, that too after experiencing such a major disaster thus added to their trauma and infused sense of insecurity.

The ones evacuated alone in the initial phase thus denied to leave till others in the group were evacuated. This added to the burden of ones engaged in relief and rescue operations. Taking clue from the experience it was later decided to evacuate people in groups rather than segregating them on the basis of age and sex. It is therefore necessary that the evacuation priorities be decided only after fully understanding the composition of the affected population.

Needs assessment: Large volume of relief supplies that reached the disaster-affected area was not actually required and handling of the same only added to the burden of the officials. Packaged water and old clothes were amongst such items; former was not required and only added to trash while the latter was not socially acceptable.

It is therefore a must after any major disaster to quickly undertake a needs assessment. The requirements so assessed should necessarily be widely publicized so that people do not send material that is not required. At the same time items that are not acceptable to the people in due to religious or cultural reasons should also be publicized. Particular attention should at the same time be paid towards safe disposal of the packing material and other waste.

Balanced response: High media attention in Kedarnath-Hemkund Sahib area resulted in initial concentration of rescue and relief efforts in this region. Ease of access for the media personnel to the center stage of post-disaster operations due to concentration of aerial rescue effort in this area further strengthened this trend. To the ones following the disaster through media it seemed if the disaster was restricted to the Mandakini valley.

The assistance coming from civil society groups and corporate houses was thus concentrated in this region. This region therefore had excess of relief supplies as also other assistance while disaster affected areas of Pithoragarh and Bageshwar did not receive much attention. Moreover even within this region the stranded persons attained high attention while the affected local population was not adequately catered during the initial response phase.

It is therefore necessary to plan response on the basis of assessed impact and needs and all affected areas should be equally catered to. Mechanism also needs to be put in place for ensuring even distribution of the efforts put in by civil society groups and corporate houses.

Personal effects: On the aftermath of the disaster it was observed that large number of persons who had ventured to the high altitude areas did not have adequate clothing and footwear. Persons visiting the region often do not have prior experience or knowledge of climatic conditions in the mountains where temperatures could drop drastically after rains, even in summers. Moreover coming from plains where temperatures go quite high in summers it is hard for the visitors to contemplate need of carrying woolen clothing. Together with this many people particularly women are not used to wearing shoes. Walking on the hilly track with slippers or sandals often becomes painful and cumbersome. This often slows down the pace of movement.

Information on the weather related peculiarities of the region together with clothing and footwear related requirements should be made available to the potential visitors through various modes. The ones proceeding on high altitude trekking routes should necessarily be advised to carry woolen clothing, sturdy footwear and raincoat/umbrella. These items should at the same time be made available en route on sale.

Logistic support for visiting officials: The disaster involved people from more than 23 states of India and officials from most states were deputed to take care of specific requirements of the persons of their state. There were however no arrangements in place for the briefing of these officials that required information on geography, terrain, weather conditions, approach, efforts being made for search and rescue and whereabouts of the evacuated persons. Arrangements for extending logistics and secretarial support to these officials

were also not in place. All this added to the workload of the personnel manning the SEOC and carrying out other disaster management related duties.

Based upon the composition of routine visitors specific arrangements catering to the needs of the officials likely to come from different states/nations on the aftermath of any major disaster have therefore to be incorporated in the concerning SOP.

On the aftermath of the disaster there were visits of a large number of politicians and other high-ranking officials. Arrangements had therefore to be made for briefing of the visiting officials. Visits of this nature should be discouraged, if not curbed. Protocol related formalities that are attendant to the visit of such officials should necessarily be formally waived off for disaster situations so that the officials engaged is post-disaster functions are not unnecessarily occupied with protocol related arrangements that are hard to manage, particularly in disaster affected and remote areas.

The national government should enact suitable legislation on this important issue and waive off all protocol related formalities during disaster situations. Provisions pertaining to the same could be incorporated in DM Act, 2005.

Relief and rescue personnel: In view of the magnitude of the disaster large number of personnel from different state government departments were deputed to the disaster-affected and other areas for taking care of various emergency support functions. Unlike unformed services the civilian departments do not have a culture of working in shifts as also that of rotation of persons undertaking stressful duties. These persons had therefore to carry out functions entrusted upon them continuously for long periods without any break. This had distinct adverse impact on the psychological and health condition of these persons that had distinct adverse impact on their performance. This was distinctly visible in the behaviour and attitude of these persons.

It is therefore required that the working hours of the persons engaged in post-disaster functions both in the disaster affected area and at SEOC be fixed and the ones engaged in stressful tasks be rotated after a pre-determined interval. This should necessarily be incorporated in the relevant SOPs. As the post-disaster relief and rescue period could extend for a long period it is necessary to pay particular attention towards psychological, mental and physical health of the relief and rescue personnel as deterioration in the same could adversely affect quality and effectiveness of the functions being discharged by them. In the stressful post-disaster conditions particular care also needs to be taken to ensure that these personnel get proper rest and quality time for entertainment and exercise.

Demobilization of resources: On the aftermath of the disaster of 2013 large number of personnel and resources were requisitioned from uniformed forces as also various departments of the government. These were often put under the control of the administration of disaster-affected districts. As there were to protocols or SOPs in place for the demobilization of resources these were not relieved even after they had discharged functions assigned to them and there existed no specific assignment for them.

In the absence of protocols and SOPs the district administration was reluctant to certify that there was no role whatsoever for these resources in the district and therefore some of the resources were kept waiting for long periods. This was observed to be a cause of discontent for the organisations that had spared these resources at the time of exigency.

Moreover it needs to be appreciated that in view of the emergency situation resources provided by various organisations are often pulled out of deployment at some other location. Over the passage of time these might well be required at some other location. This is particularly relevant for the resources of the uniformed forces as there are basically meant for catering to security and strategic requirements and should necessarily be demobilized at the earliest after these have served their purpose.

It is therefore required that protocols and SOPs be put in place for the demobilization of resources. Ceremonial or official demobilization with words of appreciation and thankfulness would further help in building better understanding and relations between the organisations.

Briefing and debriefing: Unlike uniformed forces the civilian departments do not have a culture of routine briefing and debriefing of personnel engaged in different tasks. After the disaster of 2013 large number of persons deputed by different departments were therefore inducted on duty without formal briefing on their roles and responsibilities. This often resulted in disrupted communication or chain of command. The personnel were at the same time relieved without debriefing which often resulted in vacuum and disrupted continuity of functions. Formal documentation of important lessons learnt was also missed due to this.

It is therefore necessary to put in place SOPs for routine briefing and debriefing of the personnel engaged in post-disaster functions. This should preferably be organised at the time of change of shift or duty so that the outgoing party could provide information on the ongoing tasks, problems being faced, plan of work, and targets set for the coming period. The party taking charge should at the same time be briefed on the chain of command together with reporting format and procedures.

Media awareness: On the aftermath of the disaster it was observed that the media personnel, in their bid to make the news sensational and salable, often resorted to reporting of personal routine and eating habits of the relief and rescue personnel. This often resulted in personal embarrassment besides demoralizing the relief and rescue personnel.

Media is therefore required to be educated that good mental, psychological and physical health of relief and rescue personnel engaged in stressful and tiring tasks is inevitable for effective and smooth discharge of their functions and for this they have to be provided healthy diet and recreational opportunity. To add to it the media personnel should understand that the ones engaged in relief and rescue functions are in no way deprived of their right to personal liberty guaranteed by the Constitution of India and the same needs to be respected and honoured under all circumstances.

Though in limited number unauthenticated, fabricated and inflammatory stories were reported while positive stories pertaining to acts of personal bravery, compassion and empathy together with societal engagement were often not reported. Media persons have therefore to be educated on their role in encouraging and facilitating the masses to act and proceed in the right direction by maintaining right proportion of positive new items.

Legal issues: Soon after the disaster of 2013 a number of Public Interest Litigations were filed in the apex court alleging non-performance on the part of the state and seeking immediate judicial intervention for providing relief to disaster-affected people. There were at the same time probes by the delegations of various quasi-judicial statutory bodies that included State and National Human Rights Commission, National Commission for Women, National Commission for the Protection of Child Rights and National Commission for Scheduled Castes and Scheduled Tribes. These often sought specific information pertaining to the affect of disaster on their interest group and measures taken by the state to cater to their requirements.

No arrangements were in place for addressing legal issues and the data was also not specifically segregated to cater to the queries of the various commissions. Therefore the ones responsible for other disaster management related functions and having familiarity with the sequence of events and progress of relief measures had to share the responsibility of preparing counter affidavits and replies.

It is therefore necessary to have an overview of the legal issues that could spring up on the aftermath of a major disaster incidence and accordingly manpower should be put in place for addressing these. Apart from knowledge of legal issues the person entrusted with this responsibility should have familiarity with ongoing post-disaster efforts and initiatives.

The national government has also to take a call on this important issue and enact suitable legislation to disallow judicial interference immediately after a major disaster when the state machinery is engaged in addressing other important, vital and pressing issues. Provisions pertaining to the same could be incorporated in DM Act, 2005.

Warning generation and dissemination: Despite claims of advance warning of the incidence the information received at SEOC from India Meteorological Department (IMD) was nothing more than a general forecast of particularly heavy rainfall all through the state. With location specific and definitive warning of the impending disaster many precious lives could have been definitely saved. The disaster of June 2013 thus reiterates the need of having a reliable and robust warning generation and dissemination infrastructure.

Reliable warning and its effective communication in a decipherable manner to the population likely to be affected by the incidence is the key to saving human lives and mitigating losses. To be effective warning should however have sufficient lead-time and be precise in space, time and magnitude.

With the present state of scientific knowledge and technological advancement it is possible to generate and disseminate warnings of hydro-meteorological events well in advance. Sufficiently dense network of meteorological observatories with real time data transmission capability is however a precondition for this, particularly in the Himalayan terrain where weather parameters are highly variable over short distances. Such a meteorological network could be integrated with rainfall threshold based flood and landslide models to generate reliable warnings well in advance. A system capable of immediately communicating these warnings to the grassroots level, in a manner that suggests actions to be initiated by people at large, has to be an integral part of the warning infrastructure.

As the region is visited by tourists and pilgrims in large numbers, mobile messaging service with provision of automatic delivery of multilingual warning to all active mobile phones in the area likely to be affected by the said warning could be a viable option for this. At the same time warnings have to be displayed at places where people gather in large numbers; bus/railway stations, taxi stands, transport registration offices, tourist information/registration centers, prominent road diversions and the like. Warnings should also be aired through FM, community radio and other radio networks as also telecasted through television channels. Provisions of the Disaster Management Act, 2005 should be utilized for ensuring overriding priority to these warning messages.

It however needs to be understood that it is not easy for the masses to understand the implications of the warning received in their specific context. Moreover the warning received is of little use if the recipient is unaware of the course of action

to be followed. For the effectiveness of the warnings it is therefore necessary to undertake highly visible and aggressive mass awareness drive.

Settlement pattern: Most losses caused by the disaster were generally observed to be restricted to the proximity of rivers and streams. Traditionally the people of the area maintained safe distance from streams and settled down over middle or higher slopes of the hills. Alignment of motor roads along the rivers together with ease of construction and associated commercial incentives in the proximity of road have lately induced people to settle down close to the streams and rivers.

On the aftermath of the disaster it is required that landuse zonation be undertaken and anthropogenic activities in close proximity of rivers and streams as also in identified hazard prone areas be banned.

Aggradation: The issue of fast pace of aggradation in the disaster affected area and ensuing enhanced vulnerability of many low-lying areas in the proximity of rivers and streams has often been highlighted after the disaster of 2013. Uttarkashi, Bageshwar and Sonprayag are amongst the settlements facing this problem. Reduced transport and erosion capacity of the rivers and streams due to arrested and regulated flow due to the construction of barrages and dams and increase in the debris production due to enhanced pace of developmental initiatives, landslides and surface erosion in the hills are held responsible for this.

Debris production cannot be ruled out while undertaking developmental works in the hills but it needs to be appreciated that the present practice of rolling down the debris aggravates mass movement and deforestation besides degrading soil and water quality. It often overruns productive agricultural lands, water sources and other assets. All the loose material ultimately reaches the riverbed and enhances the pace of aggradation and adversely affects productive life and storage capacity of the reservoirs.

It is therefore required that the practice of unscientific disposal of debris be discontinued and a policy be enacted for ensuring safe and systematic debris disposal with adequate punitive measures for non-compliance.

Risk transfer: The disaster derailed the economy of the region that is largely dependent upon pilgrimage and tourism. Large number of persons engaged in hospitality, transport, tourism and related sectors faced severe hardships due to sudden and unexpected downfall in the number of pilgrims, tourists and others visiting the area.

In a bid to infuse new vigor into the economy the state resorted to waiving off state dues besides enhancing the rate of relief admissible to disaster victims and

bringing losses of almost all categories under the umbrella of relief. Thus relief also covered losses incurred to commercial establishments. All this amounted to massive burden upon public exchequer.

It is therefore required that risk transfer (insurance) be made a precondition for operating any commercial establishment and the same be linked to licensing of these establishments. Risk transfer measures should also be promoted amongst general public and financial institutions, particularly banks should be persuaded to ensure insurance of all assets created with their assistance. Besides reducing the burden upon public exchequer in case of a major disaster incidence this would better compensate the disaster-affected population. Risk transfer at the same time has the potential of compensating indirect loss incurred to enterprises due to disaster incidences.

Risk informed decision-making: Post-disaster review of the situation brought forth the issue of risk assessment, risk communication and risk informed decision-making. All these were observed to be missing and therefore risk of any of the hazards was not being taken note of even while taking planned organizational decisions. Unaware of the potential risk masses were observed to do what suited them best. It was also observed that despite a strong tradition of disaster risk reduction people were not following the age old and time-tested principles that ensured safety of their community in this hazard prone terrain all through. Lately the people had started to settle down dangerously close to rivers and streams and over riverine terraces that were traditionally left for agriculture alone. The people were also observed to have discontinued traditional earthquake-safe construction practices (Rautela, 2005, 2013, 2015, Rautela et al., 2008, 2009). All this is attributed to (i) status attached to modern infrastructure, (ii) social stigma attached to traditional practices that are considered backward, (iii) peer pressure and (iv) emulation. These are held responsible for enhanced vulnerability of the masses in the hills.

It is therefore required that detailed risk assessment be undertaken and the results of the same be made available to the masses in an easily decipherable manner. Together with this appropriate, site specific and simple risk reduction options should be made available and popularized. At the same time it is required that the traditional disaster risk reduction practices of the people be researched, improvised and amalgamated with modern science and technology so as to come up with socially acceptable, economically viable, innovative and sustainable disaster risk reduction solutions.

References

Allen SK, Rastner IP, Arora IM, Huggel IC, Stoffel IM (2015) Lake outburst and debris flow disaster at Kedarnath, June 2013: hydrometeorological triggering and topographic predisposition. Landslides: 1-15.

Bandyopadhyay Sunando, Kar Nabendu Sekhar (2014) The Kedarnath disaster: in search of scientific reasoning. Current Science 107(4): 557.

CAG (2010) Report of the Comptroller and Auditor General of India. Available online at http://cag.gov.in/sites/default/files/audit_report_files/Uttarakhand_Civil_2010.pdf.

Chattoraj Shovan Lal, Champatiray PK (2015) Simulation and modeling of debris flows using satellite derived data: A case study from Kedarnath Area. International Journal of Geomatics and Geosciences 6(2):1498-1511.

Chopra Ravi (2014) Uttarakhand: Development and ecological sustainability. Oxfam India: 41 pp.

Dobhal DP, Gupta Anil K, Mehta Manish, Khandelwal DD (2013) Kedarnath disaster: facts and plausible causes. Current Science 105(2):171-74.

Dube Anumeha, Ashrit Raghavendra, Ashish Amit, Sharma Kuldeep, Iyengar GR, Rajagopal EN, Basu Swati (2014) Forecasting the heavy rainfall during Himalayan flooding—June 2013. Weather and Climate Extremes 4:22–34.

Expert Committee Report (2014) Assessment of environmental degradation and impact of hydroelectric projects during the June 2013 disaster in Uttarakhand. The Ministry of Environment and Forests Government of India: 226 pp.

IMD (2013) A preliminary report on heavy rainfall over Uttarakhand during 16-18 June 2013. Government of India, Ministry of Earth Science, Indian Meteorological Department, Lodi Road, New Delhi, July 2013.

Indian Standard (IS): 1893 Part I (2002) Criteria for earthquake resistant design of structures. Bureau of Indian Standards, New Delhi.

Kotal SD, Sen Roy Soma, Roy Bhowmik SK (2014) Catastrophic heavy rainfall episode over Uttarakhand during 16–18 June 2013–observational aspects. Current Science 107(2):234-45.

Mehta Manish, Majeed Z, Dobhal DP, Srivastava P, (2012) Geomorphological evidences of post-LGM glacial advancements in the Himalaya: A study from Chorabari Glacier, Garhwal Himalaya, India. Journal of Earth System Science, 21(1):149–63.

Rana Naresh, Singh Sunil, Sundriyal YP, Juyal Navin (2013) Recent and past floods in the Alaknanda valley: causes and consequences. Current Science 105(9):1209-12.

Rautela Piyoosh (2005) Indigenous technical knowledge inputs for effective disaster management in the fragile Himalayan ecosystem. Disaster Prevention and Management 14(2):233-41.

Rautela Piyoosh, Joshi GC, Bhaisora B (2008) Earthquake – safe Koti Banal architecture of Uttarakhand, India. Current Science 95(4):475–81.

Rautela Piyoosh, Joshi GC, Bhaisora B (2009) Earthquake safety elements in traditional Koti Banal architecture of Uttarakhand, India. Disaster Prevention and Management 18(3):299–316.

Rautela Piyoosh (2013) Lessons learnt from the deluge of Kedarnath, Uttarakhand, India. Asian Journal of Environment and Disaster Management 5(2):1-9.

Rautela Piyoosh (2015) Traditional practices of the people of Uttarakhand Himalaya in India and relevance of these in disaster risk reduction in present times. International Journal of Disaster Risk Reduction 13:281–290.

Singh R, Singh D, Gokani SA, Buchunde PS, Singh RP, Singh AK (2015) Brief Communication: Climate, topographical and meteorological investigation of the 16–17 June 2013 Kedarnath (India) disaster causes. Natural Hazards and Earth System Sciences Discussions 3: 941–953.

Uttarakhand Flood Disaster: Role of Human Actions. Dams, rivers and people, 11 (5-6), 2013, 1-32.

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Disaster Risk Reduction Personnel Training

Dr. K. R. SASTRY

Abstract

Disasters of one type or the other happens all the time. Lately, Climate Change (CC) has a huge impact on occurrence of natural hazards, calling for improved preparation to mitigate disaster and climate-induced risks. All stakeholders (Government officials, civil society and communities) should be able to overcome this misery through counter disaster trainings; or else, they become more susceptible to devastation. The Disaster Management Act, 2005 emphasizes on mainstreaming Disaster Risk Reduction (DRR) into development, which becomes the fundamental responsibility of all Government personnel. Ad hoc approaches to DRR trainings are less effective. The latest technologies should be adopted in a people-friendly environment so that traditional wisdom of communities could converge with versatilities of frontier technical knowledge acquired by responders, when disasters strike suddenly.

Keywords: *Training, Mainstreaming, Disaster Risk Reduction, Climate Change, Community's Resilience, State/District Disaster Management Plans*

Introduction

In brief, disaster management is an important issue in the development realm. Development is a complex phenomenon and can perhaps be equated with economic growth. In India's developmental trajectory, Disaster Risk Reduction (DRR), simply referred to as disaster reduction, meaning fostering risk mitigation, must help bolster resilience of communities to face calamities with composure.[1] Furthermore, disaster mitigation planning will have to be taken up alongside both environment and development concerns. It has been realized that disasters erode developmental gains when they are not adequately protected. In point of fact, it has been observed that disasters and socio-economic development are closely connected; and, the gains of development are envisaged to addressing disaster risks, but however there is also a possibility for the turn around to take place. Investments in disaster reduction normally signalize huge savings in terms of unwarranted losses and restoration costs. DRR is, therefore, a means of reducing the costs of poverty alleviation and of addressing the underlying risk features. This means that the real cost of addressing the underlying risk drivers is actually less, if DRR is incorporated into development. On the over all, the new paradigm shift with regard to disaster reduction signifies that development cannot be sustained unless disaster mitigation is built into the development process. It also emanates from the conviction that investments

in mitigation are much more cost effective than spending unnecessarily on the relief, reconstruction and rehabilitation measures.

It was resolved at the Sendai Conference, held in Japan, on 18 March 2015 to firm up a new global agenda, which became popular as Sendai Framework (SF) for a re-engineered action to shape a more "solid," "people-led," "people-centered" and "peopled-owned" implementation program for the next 15 years, i.e., till 2030. In essence, the key requirement was to help all the countries to strengthen governance arrangements and improve management of investments for addressing the underlying risk factors and ensure that DRR is incorporated into every investment, for example, creation and maintenance of critical infrastructure. The Sendai Report of 2012[2] argues that the "practice of DRR is a defining characteristic of resilient societies, and should therefore be integrated–or 'mainstreamed'–into all aspects of development." To attain socio-economic transformation of India, role of capacity building in realizing DRR should not be undermined. One of the ways to realize this vision is by organizing uninterrupted realistic training programs for DRR personnel belonging to all the development ministries/departments in the Government. More to the point, climate change (CC) continues to rise on the schema of practitioners and policy people obsessed with the mounting evidence that it is real, observable and threatening to undermine the fruits of development.

By and large, the findings of the United Nations Inter-governmental Panel on Climate Change (UNIPCC) were approved by the national academies of science of all the G-8 Nations consisting of France, Germany, Italy, Japan, the UK, the US, Canada, and Russia— as well as those of China, India and Brazil. Many more think that Climate Change has a direct impact on the prevalence and gravity of disasters in addition to causing them more frequently. As a result, there have been growing efforts to mainstreaming DRR and Climate Change Adaptation (CCA) both in precept and practice into development. Accordingly, a comprehensive training apropos linking DRR and CCA into development plans should be taken up, to facilitate addressing these intertwined concerns[3]. A spurt in the intensity of natural disasters with increasing frequency and tenacity, induced by man's dalliance with nature; and, the associated activity and attendant losses subsuming financial overheads is mounting pressure on the need for improved approaches, procedures, skills and tools to evaluate and alleviate disaster risks.[4]

India is vulnerable to a large number of natural and man-made disasters. According to the Global Assessment Report of the United Nations Office for International Strategy for Disaster Reduction (UNISDR), India loses $ 9 Billion every year due to disasters as its 58.6 per cent land mass is prone to earthquake of moderate to very high intensity; over 40 million hectares (12 per cent) of land

is prone to floods and river erosion; and, of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and Tsunamis[5]. Over 68 per cent of the arable area is prone to drought; while the hilly areas are at risk of landslides and avalanches. Vulnerability to disasters of Chemical, Biological, Radiological and Nuclear (CBRN) origin does subsist. Emergencies, mainly those that occur in nature, might become cataclysmic events, when they join with vulnerability factors like where settlements are allowed to make and creating serious situations for population density.[6]

Subsequently, DRR aims at minimizing disaster losses in the short-term and bring into being some attainable measures like capacity building of public, private and community organizations besides strengthening their institutional competencies, as for instance, coping mechanisms; and, as a result making the community more resilient to face disasters with equanimity and to effectively manage new challenges. One ought to be aware of the massive impact the climate change is encompassing on weather patterns, hydro-meteorological incidents and the frequency, intensity and unpredictability coupled with events of natural hazards. Without alleviation, these calamities will leave communities and countries more susceptible to devastation. Therefore, mitigation measures should involve both structural and non-structural measures, in which counter-disaster staff training becomes vital.[7]

DRR & CCA: The Twin National Concerns

Undeniably, global climate change accelerates degradation of ecosystems and increase in disaster risks owing to rising severe weather-related risks: heat and cold waves, landslides, floods, drought, etc. On the contrary, healthy, well-managed ecosystems are more vigorous against vulnerabilities within the critical sectors encompassing agriculture, animal husbandry, fisheries, water, forestry and health. A holistic approach to restore degraded environments to attain durable livelihoods through DRR and CCA is the sine-qua-non. Every effective development and planning process requires taking CCA on board. On the other hand, adaptation efforts themselves will often require several different kinds of interventions including creation of awareness among the communities to succeed. So, a comprehensive training program apropos mainstreaming DRR and CCA into development plans should be taken up to facilitate addressing these twin but entangled concerns for all the stakeholders, especially, the Government officials, elected representatives (ERs) and the civil society organizations (CSOs).

Possibly, DRR and CCA are integrated to some extent at the apex level due to India's commitment toward Hyogo Framework for Action (HFA: 2005-15)[8] and the National Action Plan on Climate Change (NAPCC-2008)[9]. Furthermore,

a range of sector-wise subjects like water supply; health; agriculture; rural development, urban development, etc., embrace activities that could handle climate change and disaster resilience. On the contrary, when execution of these schemes is examined at the national, state, district and local levels, it is evident that there was no attempt made to integrate DRR and CCA features into the sector-wise agenda of various ministries and departments. Such omissions weaken the facility to interpret DRR or CCA policies into action plans at the cutting edge level. This is where capacity development of Government staff engaged in planning and execution of developmental activities comes in handy. Making them conscious of the advantages of mainstreaming DRR and CCA into development planning will go far afield.

Thurst & Strategy

It was observed that the absence of coordinated emergency response among national, state and district levels is a major issue to attend to. For example, it is vital that the District Planning Committee (DPC) (buttressed by the Constitution 74th Amendment), be trained on mainstreaming DRR and CCA, as it plays a crucial role in identifying mitigation activities for various disaster prone regions under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). This needs inclusion of DRR and CCA experts in program review committees to help the DPCs to appreciate the knowledge gaps with regard to precept and practice.

It follows that a comprehensive disaster reduction strategy ought to include coordinated and defined roles and responsibilities of officials; state and local governments, including Panchayati Raj Institutions (PRIs) to implement a timely response to emergencies; and, mainstreaming of local communities into an effective disaster reduction apparatus. In this task, the District Disaster Management Authorities (DDMAs) play a pivotal role as they represent a potential entry point for integration of DRR and CCA concerns into development. Furthermore, it may be stressed that DDMAs are district level organizations with a robust presence across the country, where all the development departments join forces, and offer a unique platform for integration of DRR and CCA concerns into District Disaster Management Plans (DDMPs)

The prime driving force for disaster reduction is to outline a course of action besides constructing an edifice for synchronized and efficient mainstreaming of DRR into development plans, delivery of adequate assistance, and addressing the consequences of various calamities with appropriate alleviating measures, as enjoined by the Disaster Management Act of 2005. Also, one can even perceive the emphasis of the Disaster Management Act (in particular, Section 11 B) on mainstreaming DRR. A comprehensive disaster reduction strategy

would include coordinated and clear-cut roles and responsibilities, capacity of national, state and local governments to implement a timely response to disasters and integration of local level communities into effective disaster management systems. Improving the capacity of DDMAs toward integration of DRR and CCA concerns represents a potential entry point to address the gaps in implementation.

Engendering "political will" with raising public responsiveness apropos the nature and value of mainstreaming DRR and CCA is one of the important issues now. This would make clear the issues of governance and "political commitment" to the elected representatives (ERs) like MPs, MLAs and elected leaders of Panchayati Raj Institutions (PRIs). The strategy currently adopted is developing trainers by organizing Training of Trainers (ToT) programs for staff of training institutions, which in turn, help prepare the Government personnel for public service. Concepts of DRR and CCA should be inculcated in unison with mandatory training during the initial years of officers' grounding by the training institutions. The National Institute of Disaster Management (NIDM), Administrative Training Institutes (ATIs) and State Institutes of Rural Development (SIRDs) across the country should conduct refresher courses from time to time. Help from various sources having considerable knowledge on calamities vis-à-vis management of environment, now labeled Climate Change Adaptation and DRR in preparedness planning is the sine-qua-non. This could be launched at the State, District, Block, Village and Community levels. The number of target groups could be larger as it includes officials of all government departments, legislative elites like MPs, MLAs, elected representatives of PRIs and Civil Society Organizations (CSOs), namely, NGOs and CBOs.[10]

Disaster Reduction Training

(a) Need for training of personnel

In India, certain types of disasters are recurrent in certain areas and their vulnerability could be estimated well in advance. Specific measures, i.e., action plans of long-term and short-term natures could be prepared and implemented to lessen the ill-effects in potentially disaster-prone areas. In the process, there is a dire need to look at the contemporary DRR measures and review the existing and long-term development policies; and counter-disaster and CCA training for personnel is one of the strategies envisaged in this regard. Training programs ought to cover areas affected by a variety of calamities, i.e., cyclone, earthquake, flood and drought by bringing awareness among various stakeholders such as officials, non-officials, civil society, corporate bodies, community, etc., in relation to ways of improving the situation, in the context of mainstreaming DRR and CCA with Sustainable Development.

(b) Objectives of personnel training

The process of analyzing disaster threats and reduction of the likely consequences to society, the economy and critical infrastructure, has been undertaken in order to identify the tasks that would crop up in meeting the needs of the situation each and every time a disaster strikes. Responsibilities for meeting those tasks should be fixed; also, the variety of disaster preparedness measures necessary should be listed. On the road to participative planning, all those with responsibilities in planning are to be involved in disaster reduction and preparedness. In this context, data collection, data mining along with creation and maintenance of management information systems (MIS) turn out to be the outcome.

According to G.N. Ritchie, logistics planning and resources management, establishing connects between relief and preparedness as well as post-disaster recovery in addition to ongoing DRR and development processes need to be organized. Public education and information programs are intended to increase community awareness and commitment to preparedness besides creating attitudes of self-help as opposed to dependence, by drawing mostly on the traditional local knowledge and experiences they internalize, nurture and own eventually.[11] Training should regularly upgrade the staff skills by increasing its capacity to rescue, recover and manage shelters in addition to maintaining good sanitation and hygiene. In this task, Government must buttress CSOs, Public and Private Partnerships (PPPs), Corporate Social Responsibility (CSR)--perceived to be the main theme for special consideration of the present Union Government,[12] to ensure effective environmental conservation in both urban and rural settings.

Disaster Reduction: Raison D'être

It must be averred that disaster reduction and preparedness planning should be carried out as an unending responsibility of Governments; and, its absence is visibly a major factor in the overkill of administration in disaster situations and consequent delays in response and relief administration. To tackle climate change and disaster impacts locally, all the developmental programs implemented by the Government should have, as main features, environment impact assessment and hazard impact analysis. Plausibly, such efforts could help reduce the debilitating effects of development policies on contiguous social, economic and natural environments.[13]

Organizing appreciation programs do a must for host of target groups comprising senior officials, holding responsible positions in the government, elected leaders--MPs, MLAs, representatives of PRIs, CSOs, both print and electronic media as well as policy makers. Such programs would help develop awareness and understanding on relations between a triangle of concerns--DRR,

CAA and Sustainable Development of the nature, value and cost-effectiveness of mitigation and preparedness practices. Mainstreaming DRR, CCA and Sustainable Development should be considered an unremitting responsibility of all the personnel belonging to diverse government departments, irrespective of their academic backgrounds. Normally, training should be imparted to the personnel at their entry point of service itself; and, should be followed up by periodic updating, i.e., once every two to three years or so.

Need for an Action Plan

An important responsibility of coordination at various levels would be the preparation of development plans incorporating features of DRR and CCA. This would help mobilize, coordinate and deploy the state's resources in response to DRR. A broad action plan would help coordinate activities of different organizations besides their specific roles and responsibilities in meeting the tasks of this plan. However, executing such a plan becomes the responsibility of persons or groups requiring an unambiguous understanding of their individual responsibilities plus working out the practices associated with it. To foot the training of state disaster relief organizations vis-à-vis cogent objectives, the training should be directly related to the tasks delineated in the state disaster preparedness plan. Once a plan is in place, all training could be centered on realistic objectives and ceases to be academic. So, those involved could be the persons fit into the scheme of things; and, plan with an apparent knowledge as to what is required of them. Professional training of this nature ought to take place in so far as possible in the Administrative Training Institutes (ATIs) and State Institutes of Rural Development (SIRDs). The appreciation programs pave way for both team spirit and joint effort on which successful operations in emergencies could occur.[14]

India's National Disaster Management Plan

As recently as on 18 May 2016, Prime Minister Narendra Modi, released India's first ever National Disaster Management Plan (NDMP). In his own words: "the aim of the Plan is to make India disaster resilient. It will help to maximize the activity of the country to cope with disasters at all levels by integrating disaster management into development and by increasing the preparedness to respond to all kinds of disasters."[15] The plan subsumes a comprehensive strategy to deal with several different kinds of disasters; and, thereby incorporating the Sendai Framework (SF), the latest international event, for which India is a signatory.

The response part of NDMP will help prepare an early warning system, along with proper maps and satellite inputs, and will also focus on faster dissemination of information and evolving better coordination across multiple agencies. The

plan deals with quick evacuation of people and livestock, medical care, food and essential supplies, power, housing and temporary shelters and supply of drinking water, logistics and transportation in a disaster situation. It also looks into the role of various agencies like officials, elected representatives and NGOs at the Centre, State and Local levels during a disaster. In summary, the strategy includes, inter alia, evacuation of people and animals, search and rescue (SAR) operations, medical care, food and essential supplies during emergencies.[16] In all these designated tasks, the role of counter-disaster personnel cannot be diluted.

Opoerationalization of "Polluter-Pays" Principle in India

An important subject, on which both the trainers and trainees must have a clearer understanding is the "Polluter Pay's Principle," as applicable to India. The general notion has been that industrial organizations will not take the environmental assessment analysis into proper consideration, which leads to polluting the environment; and, it is at this level the Climate Change Adaptation (CCA) should be practiced vigorously. Only then will it be effective. A provision for financial compensation based on the polluter pay's principle, for the ill-effects caused by careless industrialization should be the end result.

On the theme in question, Barbara Luppia, Francesco Parisi and Shruti Rajagopalan have asserted that: "The polluter-pay's principle stipulates that the person who damages the environment must bear the cost of such damage. A number of developing countries *(including India)* have recently extended this principle to create an obligation on the State to compensate the victims of environmental harm. This variation of the polluter-pay's principle is aimed at ensuring victims' compensation when polluters cannot be identified or are insolvent and at providing stronger incentives for local governments' monitoring of environmentally risky activities. These regimes hold local governments primarily or jointly-and-severally liable for environmental damage and allow them to act in subrogation against the polluters."[17]

The authors have examined: "the effect of the forms of governmental liability on the polluters' incentives and on aggregate levels of environmental harm." *Moreover, the authors have also developed* "an economic model to study the conditions under which governmental liability may be preferable to direct polluters' liability as an instrument of environmental protection". *In summary, the authors have suggested that* "variations of the polluter-pay's regime may be desirable in environments characterized by widespread poverty, high interest rates, judicial delays and uncertainty in adjudication".[18]

That said, while speaking on the citizens' rights in respect of social justice and contemporary situation regarding the "Polluter Pay's Principle," the-then

Chief Justice of India, T.S. Thakur, opined that "it is easy to pin accusations of environment degradation and climate change on emerging economies like India, while advanced nations like the US have been emitting carbon ten times more than India for the past 200 years." Justice Thakur further observed that an international framework should also be evolved to apply "the Polluter Pay's principle" to all the advanced economies.[19]

Conclusion

To sum up, training is not a one-off phenomenon. As a result, it is appropriate to reiterate that *ad hoc* or impulsive approaches to disaster reduction are less effective and counter-productive. It is essential to evolve location-specific strategies in a decentralized participative planning process. The state-of-the-art technologies need to be initiated in a people-friendly environment so that the traditional wisdom of the communities could converge with the versatilities of frontier technical knowledge of trained responders when disasters strike with impunity. According to a Study on Financing DRR under the aegis of the Global Facility for Disaster Reduction and Recovery (GFDRR [2013]), "While policy debates and considerations of best financing practices might occupy attention, disasters continue to make their impact felt both nationally and locally. Massive sudden impact-disasters destroy communities in an instant, while the socio-economic fabric of nations is eaten away by slow-onset disasters such as drought, month-by-month, year-by-year."[20] Accordingly, some of the budgetary allocations and certain percentage of development aid toward relief and rehabilitation should be made available to manage these covariate shocks. Unquestionably, people are the real wealth of a nation. Hence, communities comprising people form the most willingly available work-force in India could be gainfully employed and deployed for disaster risk reduction to deflect the perils occurring frequently.[21] For this reason, the mainstreaming of DRR and CCA into development should aim at transforming the existing hazardous situation into motivating the communities' resilience in conjunction with continuous preparedness; and, thereby resulting in achieving robust sustainable development.

Refeences

1 Sastry, K.R: "Mainstreaming of DRR: Initiatives of CSOs and Fresh Leads," at the *International Conference*: Samutthan Foundation, New Delhi. 2014

2 The Sendai Report: Managing Disaster Risks for a Resilient Future: Global Facility for Disaster Reduction (GFDRR) 2012

3 UNDP Workshopon DRR: Andhra Pradesh Academy Rural Development, Hyderabad, December 2014

4 Thomas, Vinod., Director General, Evaluation, World Bank, The Economic Times, 2007

5 Deccan Chronicle, 5 May 2015.
6 Government of India, National Disaster Management Authority, 2005
7 Thomas, Vinod.. op cit.
8 The Hyogo Framework for Action (HFA), Japan: *United Nations*, 2005.
9 The National Action Plan on Climate Change (NAPCC), New Delhi, 2008.
10 Government of India:. National Disaster Management Policy, *NDMA*, New Delhi, 2009
11 Ritche, G. N. "Counter disaster staff training," *Asia-Pacific Journal of Rural Development*, Vol. 10. No.2. 2000, pp. 93-100,
12 Quoted from the Union Finance Minister's Budget Speech, New Delhi, 2015
13 Ritche, G. N., op.cit
14 Ritche, loc. cit
15 Taken from the National Disaster Management Plan, NDMA, New Delhi, May 2016
16 *Ibid*
17 Quoted from the Abstract of the article by Barbara Luppia, Francesco Parisi, et al., The rise and fall of the polluter-pays principle in developing countries," *International Review of Law and Economics,* 32, 2012, pp. 135– 144
18 *Ibid.* the insertion in *italics* is mine.
19 Thakur, T.S., Hindu 'Developed economies, not India should be blamed for CC" 3 July 2016
20 Kellett, J. & Alice, C. Financing DRR: 20 Year Story of International Aid, GFDRR, 2013
21 Jagirdhar, Meena & Sastry, KR. "Community Based Disaster Risk Reduction." LBSNNA Journal: *Disaster: Response and Management* Vol. 2 No.1, 2014, pp. 11-18

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A tragic landslide event at Malin village in 2014 – A retrospective development in Eco-sensitive area, a part of the Western Ghat, India.

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Abstract

Western Ghats are a mountain range, faulted and eroded Deccan Plateau with an average elevation of 1,000 m above the msl, predominantly comprises basaltic rock, which runs nearly parallel to the western coast of the Indian Peninsula and also north to south. It is one of the UNESCO World Heritage Site and also is one of the hottest hotspot of biodiversity in the world and considered as an Ecologically Sensitive Area (ESA). It passes through Gujarat, Goa, Maharashtra, Tamil Nadu and Kerala states of India with a length of approximately 1,600 km.

Malin village is a part of Western Ghats which has a high degree of complexity arising out of a variety of non-linear interactions between its component such as rich Biodiversity, Hydrological Systems, Geological and Geomorphological characteristics and Climatic Variations coupled with human interventions. The area is also a part of ecologically sensitive, fragile geological conditions and geo-tectonic settings, greatly has been affected by various developmental activities such as Padkai scheme initiated in the year 2011-12, extensive infrastructure development, rural road development under the scheme of Pradhan Mantri Gram Sadak Yojana (PMGSY), Western Ghats Development Programme (WGDP) and alteration of slope for extensive rice cultivation. Ecosystem of the area has been severely shattered and threatened by human intervention, rise in human population, over-exploitation of natural resources, deforestation, infrastructure development and tourism development.

The area is characterized by rugged hills with steep slope associated with loose unconsolidated soil. With its peak occurrence during the monsoon season, the magnitude of its effects can be disastrous depending on certain additional controlling factors for both natural and anthropogenic.

Malin is a small village in the Ambegaon Taluka of the Pune district, Maharashtra State, located in the Sahyadri foothills where catastrophic landslide struck on 30 July, 2014 at 7.45 am while most of the people were in sleep. There was no early warning from the Indian Meteorological Department. This disastrous landslide

triggered by accumulated heavy rainfall since 22 July 2014. This tragic event killed 151 people, buried 45 houses, affected 40 families, destroyed 120 m length of road section and affected 44,245 sq. m. of land area.

Keywords: *Malin village, Western Ghat, Eco-environmental sensitive area, geologically fragile, landslide, tragedy, Climate Change, developmental activities, Padkai scheme, disaster, community awareness and disaster resilient community.*

Background:

Vulnerability to natural hazards is on the rise, it is an increasing source of concern for the community. Indeed, urbanization, alteration of the natural environment, substandard dwellings and public buildings, inadequate infrastructure maintenance, global climate change and grinding poverty in numerous communities have all intensified the risks of natural disaster. Disasters caused by landslides are one of the significant natural catastrophes primarily in the hilly terrain (**Sassa, Kyoji, et al., 2013**).

Large and small landslides occur almost every year in nearly all regions of the world. At a time when the international community is progressively and resolutely addressing challenges posed by natural hazards, scientific knowledge and technological know-how must be further mobilized to assess landslide risks and to enforce sound scientific, engineering and construction principles for the protection against such risks. In landslide-prone zones, decision-making for housing and urban planning must integrate landslide risk (**Sassa, Kyoji, et al., 2013**).

In general, landslides occur in hills / mountains in response to a wide variety of terrain conditions and triggering processes like heavy rainstorms, cloudbursts, earthquakes, floods and unsafe developmental activities. As per an assessment, more than 5000 people are buried alive under landslides and economic losses of > 4 bn USD occur every year, globally. With growing population, urbanization and human interventions in terms of developmental activities over unstable slopes, landslides pose increasing risk to human lives, buildings, infra-structures, livelihood and environment. Large scale deforestation along with faulty management has enhanced vulnerability to landslides in many regions of the country. Human activities relating to expansion on unsafe locations, unscientific mining, unsafe construction of roads and dams, ignoring natural features contribute to increased intensity of landslides (**Parkash, S., 2012**).

Introduction:

The Western Ghats (Figure 1), though located in a relatively stable terrain, experience the fury of this natural hazard due to steep hill slopes, overburden, and high intensity rainfall. The Western Ghats, exhibited numerous scars of landslides due to their location in a zone of high intensity rainfall and oversaturation of overburden material (**NDMA, 2009**).

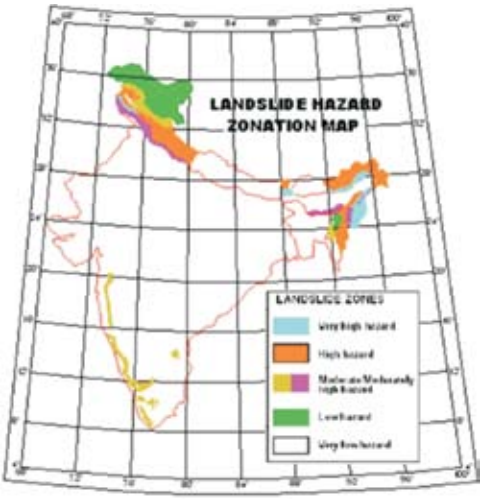

Figure 1: Landslide Hazard Zonation map (Source: NDMA, 2009)

Malin village located on the slopes of the "Sahyadri" the North-South running Western Ghats section in Maharashtra, was struck by a disaster of colossal nature in the form of a landslide. The Western Ghats are Fold Mountains and mainly consist of basaltic rocks which were formed due to solidification of magma. The area is prone to natural hazard primarily flood and landslide. Occurrences of landslides in the area are mostly due to heavy rains, particularly in the rainy season.

Malin village lies in the proximity of the 'Dimbe' dam back water and is at distance of about 28 km from multi-purpose dam site and 40 km from Ambegaon Tehsil headquarter and about 140 km from Pune. The geographical coordinates of the landslide event are latitude 19° 09'46" N and longitude of 73° 41'2" E with an elevation of 796 m. The schematic map of location of Malin village and access road is shown Figure 2. The area is drained by the Ghod River and its tributaries, one of which is called Bhubranala flowing at the base of the hill slope of Malin village. Dimbe Dam on Ghodriver is located at a distance of about 20 km (by road) downstream of the village.

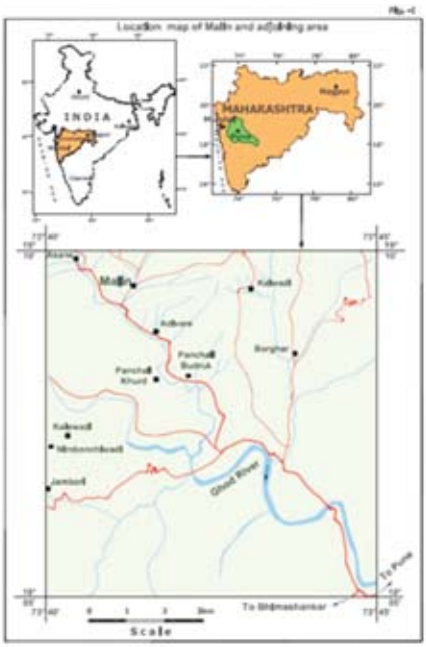

Figure 2: Schematic map of location of Malin Landslide, Pune District (Kohli et al., 2014)

Malin village is a part of Ambegaon Taluka, Pune district of Western Maharashtra. Ambegaon taluka has a total of 142 villages, out of which Malin village is one. The Malin village consist of seven hamlets. Total population of the villages is about 704 out of which 379 are male and 325 are female. Whereas, the total population of main Malin village is about 181, out of which 87 are male and 94 are female. The houses were located at six different elevations with a level difference of about 1.5 m each. The major population of the area is tribal. Adavasi Tribes are found in large number in this region (**Mungekar, Bhalchandra, 2009**).

Mostly people in this region are farmers and their livelihood is depended on the agriculture. Rainfed Paddy cultivation is the main agricultural activity in the region. The slopes at level above and below the village were partially converted to terraces for paddy cultivation. The villagers grow rice over the terrace following the contour. The area has an average annual rainfall of about 2000-2500 mm. Generally, the region is cool and falls under the moderate rainfall intensity zone.

The village Malin is a part of the eco-sensitive zone of the Western Ghats (comprises a length of 1,490 km and area of 1,29,037 sq km) and it is a part of the hotspots of biodiversity. Ecologically, the Malin village is very fragile and sensitive due to its typical geographical locations, geological conditions,

geo-tectonic settings, topography, high rainfall, degraded environment and degraded forest cover etc. The hill chain in the study area represents a treasure of biodiversity. The study area is also highly vulnerable to future climate change (**MoEF, 2011**).

The area around Malin village is represented by the basaltic lava flows belonging to the Upper Ratangad Formation of the Sahyadri Supergroup of Western Deccan Volcanic Province. Thus, the study area situated over the Deccan Volcanic province exposing horizontally layered sequence of basaltic lava flows (Deccan Traps) erupted through fissures during the culmination of the Cretaceous period (approximately 66 million years ago). The massive flow layers form flat topped vast plateaus with steep escarpments. The softer flow layers form obsequent, debris covered and vegetation packed slopes encircling such plateaus and these occur sandwiched between massive flows. These softer thin flows form vegetation rings/ bands in between the massive flows as seen in the southern part of the area (Figure 3). Contacts between the flows which have erupted with a time gap are marked by red boles and flow breccias. The lava flows are highly fractured due to cooling cracks and tectonism (**Ramasamy et. al., 2015**).

Figure 3: Oblique view of Google 3D image with representatively shown E–W fracture swarms (1) and ENE–WSW fracture valley (2), Malin Area.

Regionally, the area falls close to the NW-SE trending Kukdi-Ghod lineament zone. However, the landslide location is 12 km away from the Kukdi River and 22 km away from the Ghod lineament (Figure 4). Satellite Imagery of the study area (Figure 5) was consulted and a lineament map (Figure 6) was prepared based on visual interpretation. Most of the lineaments observed in the area are trending in NE and SW directions. Below the landslide, one lineament trending NNE-SSW passes along the Bhubra nala. This lineament does not appear to have played any role in causing the landslide (GSI, 2014 and Kohli et al., 2014).

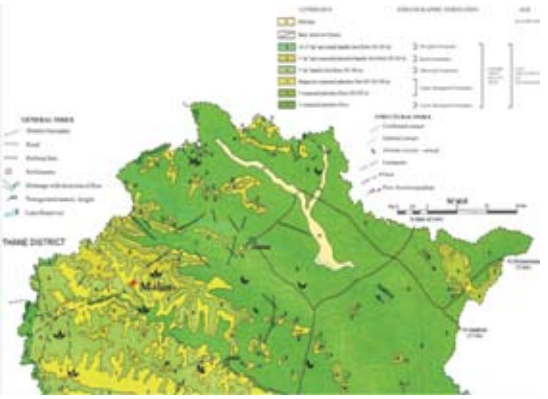

Figure 4: Geological and Neo-tectonic map of the study area (Kohli et al., 2014)

Figure 5: Satellite image of the study area (Source: Kohli et al., 2014)

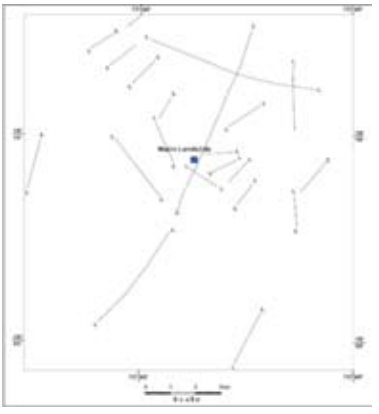

Figure 6: Lineament map of study area (Source: Kohli et al., 2014)

The seismo-tectonic map (Figure 7) of the area reveals that within the 100 km radius of the landslide location, 2 low magnitude (4. to 4.9) seismic activities originated from 0-40 km and 41-70 km depths recorded during the period between 1964 and 1993.

Figure 7: Seismo-tectonic map of India (Kumar, M. Ravi and Bhatia, S. C., 1999)

As a whole, the land use (Figure 8) has been classified into six classes i.e. heavy vegetation, light vegetation, settlement, cultivable land, water body and scrub land. The vegetation cover is an important factor which influences the occurrence and movement of the rainfall which triggers the landslides. Light Vegetation is found as the major landuse in the watershed (**Gujarathi and Mane, 2015**).

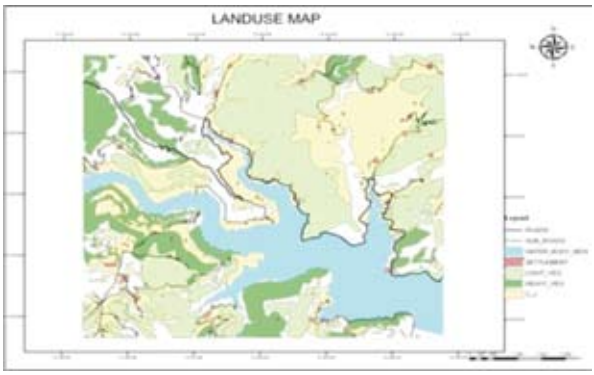

Figure 8: Land use land cover of the study area (Source: Gujarathi and Mane, 2015)

The Landslide event:

The incessant heavy rainfall since 25th July 2014 in the area triggered catastrophic landslide (Figure 9) on 30 July 2014 at Malin village at around 7.45 am while most of the people were in sleep. There was no early warning by the Indian Meteorological Department. This disastrous landslide triggered by heavy rainfall on the preceding day as well as the rainfall accumulated during past couple of days. This tragic event killed 151 people, buried 45 houses, affected 40 families, destroyed 120 m length of road section and affected 44,245 sq. m. of land area (NDRF, 2014).

The majority of the village (about 2/3rd of the village area) was completely devastated and leveled where all the Kutch houses perished. Few houses in the unaffected area (25% of the village area) of the village were severely impacted with cracks on the walls of the Kutcha house and made unsafe for staying due to ground vibration caused during debris slide movement.

Figure 9: Site of landslide event at Malin village.

The Malin landslide is located on the eastern slope of a roughly N-S trending hill. The slopes are ranging from moderately to steep. Thus the entire hill slope, on part of which the slide occurred, can be divided into four zones from Bhubranala bed to hill top based on the prominent breaks in slope (Figure 10), viz: **1st Zone:** from nala bed level to the road level (1st slope break/ level), which is relatively flatter in its lower part followed by gentler slope in upper part; **2nd Zone:** from road level to the 2nd slope break/ level, which is relatively gentler; **3rd Zone:** from 2nd major slope break/ level to the 3rd major slope break, which is moderately inclined and **4th Zone:** from 3rd level till the plateau edge/apex of hill slope, which is again moderately inclined (Kohli et. al., 2014).

Figure 10: The four slope zones identified on Malin hill slope (Kohli et al, 2014)

The length (slope length) of the 1st zone is 142 m while that of 2nd, 3rd and 4th zones are 130m, 80m and 137m respectively. The height of the landslide is roughly 190 m while the width of the slide varies from 45m to 134m. The entire length of the slide from the crown to toe is 514m. The entire landslide affected area is 44,245 sq m. The crown of the landslide is at elevation 936 m which marks the top of the 4th slope zone. The width of the landslide in this zone ranges from 45m to 62m.

The slide has dumped its debris mainly in the terrace between the 1st and the 2nd zone and its surroundings. The slided material went down to the Bhubranala (Figure 11). However, the main zone of accumulation is roughly 10586 sq m (134m width along the road and 79m length across the road). Unfortunately, this zone of accumulation is the settlement area of the Malin village.

Figure 11: Google earth image showing the synoptic view of the post disaster landside (Date of image, 4 March 2015).

Within the landslide zone, the top part of landslide (4th zone), i.e. at the crown, highly jointed basaltic (simple flow) rock is exposed (Figure 12). Joints are open and the openings are filled up with clayey and silty material. The thickness of the exposed jointed basalt is to a maximum of 9 m. Three major joints viz. J1: N300º/80ºN30º, J2:N20º/40º N290º, and J3: N50º/40º N140º are observed.

Figure 12: Basaltic rock exposed in 4th Zone bottomed

Trees may have played a role in restricting the lateral extent of the landslide and spread of its debris. One house located just above the school building, on the left edge of the slide (2nd zone) has been possibly saved from being buried due to one such fallen tree. Mud splashes are seen all over the slide-side wall of this house.

The soil on the slope is clayey to silty in nature with basaltic blocks resting/ embedded in that. The composition of the debris material is also largely silty clay with minor quantity of rock blocks embedded as was seen on the first few days when rescue operation was in full swing. The size of most of these rock blocks match those used for making bunds on the valley side edges of paddy terraces and therefore inferred to be part of the destroyed bunds that existed in the slide zone. Some of these large blocks being part of the rocky crown portion, cannot also be ruled out.

Within the slide zone, two gullies are observed. Out of these two, one is running almost along the middle of the main landslide, while another gully is observed flowing closer the right flank of the landslide (Figure 13). Both the gullies are found emerging in 3rd zone and ends in 2rd zone. These two gullies appear to have formed during the landslide incidence. One original (pre-existing) nala is present towards the northern side of the landslide.

Figure 13: Gullies within the slided zone

Nala along the slope posed severe instability issues in the area (Figure 14). The seepage of water through rocks induced instability and slope failure in the area (Figure 15). The signatures of instability of slope such as cracks to the exposed rock surface, ground surface, walls of houses and oozing of groundwater in houses at least a decade before the calamity were adequate to support the landslide event induced by both anthropogenic and natural activities i.e. accumulated rainfalls prior to the landslide.

Figure 14: Nala along the slope posses instability and slope failure.

Figure 15: Seepage of water through rock poses instability and slope failure.

Causes of the landslide

It is the natural geological setting of the region which makes it susceptible and prone to disasters. The Western Ghats is very sensitive due to complex geological

factors, make this region more vulnerable to disaster particularly landside during the rainy season. The various tectonic features like rock fracturing, faults, etc. are very common in the Western Ghats.

Google image show that this ENE–WSW fracture valley (**Ramasamy, et. al., 2015**) extends to a longer distance up to Nandgaon in the southwest, where it exhibits sinistral shifting of Deccan flows, hereafter referred to as flows (1, Figure 16). This sub-parallel set of ENE–WSW sinistral faults found to the southeast and northwest and the similar set of NW–SE dextral faults found to the northeast and southwest have bounded the Malin area as a tectonic block. These bounding faults must be causing different types of stress leading to warping and fracturing of the Malin block following the pattern of wrench fault tectonics. All these indicate that there have been strong tectonic activities in Malin area in the Post Deccan Volcanic period (**Ramasamy, et. al., 2015**).

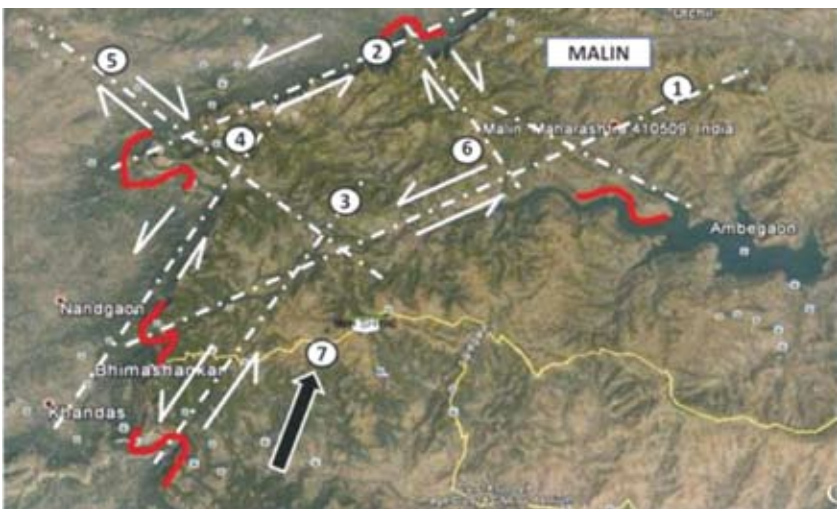

Figure 16: Oblique view of Google 3D image showing ENE–WSW (1&2) and NE–SW sinistral faults (3&4), NW–SE dextral faults (5&6), dragging of flows and NNE compressive force, Malin Area (Source: Ramasamy, et. al., 2015)

While the flat topped hill of the topmost flow west of Malin village has been deforested for cultivation, the underlying flow plains located just above the upslope region of Malin village are being marginally used for cultivation. Thus, Malin landslides are the cumulative effect of accumulated rainfall, tectonism and anthropogenic activities (**Ramasamy, et. al., 2015**).

The post-collision tectonic model developed for the Indian plate shows that the north to north–north easterly force which originally drifted the Indian plate is still active and pushing the Indian plate towards northerly directions. As the

tectonics of the Malin area is controlled by similar ENE–WSW to NE–SW sinistral and NW–SE dextral faults, the input of regional tectonics over the Malin area cannot be ruled out (**Ramasamy et. al., 2015**).

Malin village does not have a rain gauge station and therefore, rainfall data recorded in different rain gauge stations located around Malin were collected from the Tehsildar office, Ambegaon. The following table (Figure 17) is the rainfall data recorded in Dimbe rain gauge station during the last week of July and first week of August 2014. Among the rain gauge stations, Dimbe rain gauge station at Dimbe Dam site, the nearest to Malin village, may not represent the actual rainfall that has been experienced by the Malin village area.

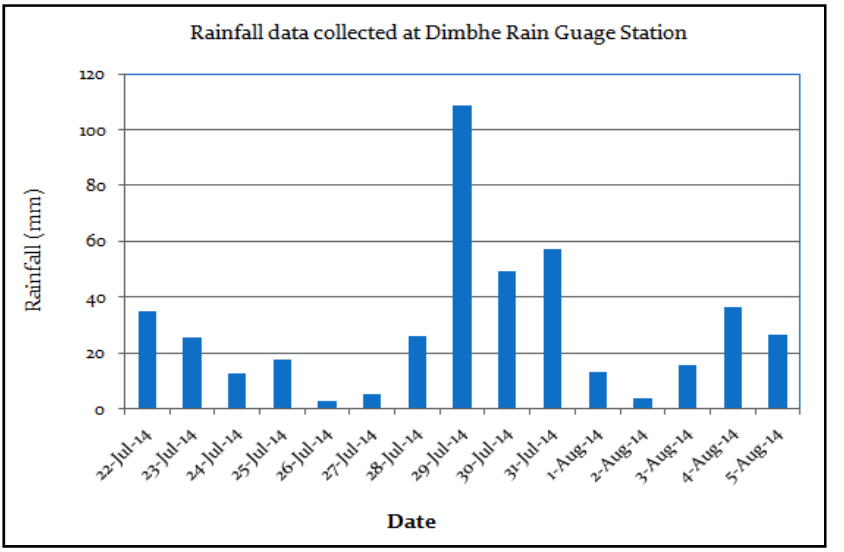

Figure 17: Rainfall at Dimbe Rain gauge station

It was observed that during the previous few days from July 22nd to 28th, the antecedent rainfall was nothing extra-ordinary, ranges from 2.5 to 34.75 mm only per day. However the rainfall record for July 29th shows 108 mm, may have played a significant role.

Rainfall data were compared with the some stations of the same date, it was observed that rainfall (Figure 18) in the month of June 2013 (at Dimbe rain gauge station) exceeds that of the July 2014. However, there was no landslide reported during June 2013.

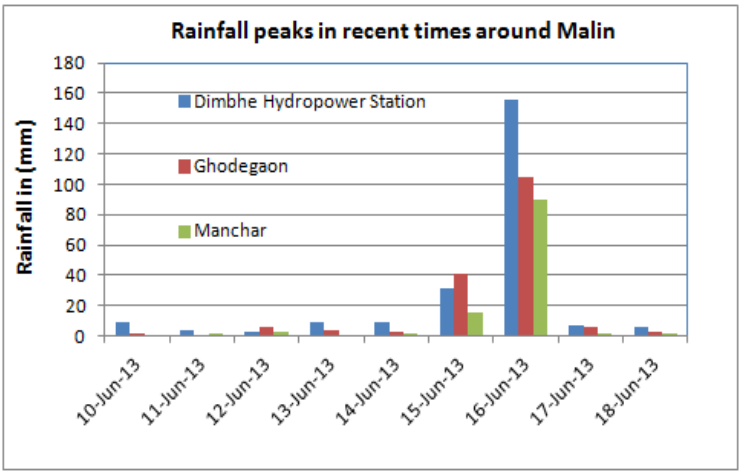

Figure 18: Rainfall at different Rain gauge station in the year 2013 for comparison

The natural instability and fragility of the landmass, coupled with ecological degradation, unwarranted changes of landscape under impact of various developmental and engineering projects and faulty housing practices in the hilly region makes it more vulnerable and prone to disasters. Given the circumstances of socio-economic vulnerability, slight disturbances in the eco-sensitive zone, either due to human induced activities or other natural causes, can also lead to disasters. Unscientific development and land-use practices, poor socio-economic conditions, deforestation, increasing human pressure, increasing tourism pressure, etc. have also contributed to the factors governing vulnerability of people of the region to disasters.

Poor socio-economic conditions, either due to loss of environmental sustainability or degradation of natural resources, and inadequate avenues of alternative livelihood and prospects of local economic development, along with marginalization, non-access to goods and services, illiteracy and ignorance, govern people's preparedness and capacity to withstand a disaster. Poverty and deprivation, with lack of economic base to sustain and maintain safe housing and occupations extensively contribute to the vulnerability of the people. Lack of resources and capacity makes poor settle in hazardous and more vulnerable areas. However, changing livelihood choices and increased social aspirations also increased vulnerability.

People living in this area are belongs tribal (i.e. 95% of the total main Malin village) community. Most of them are poor farmers, their livelihood is depended purely on the agricultural activity. To improve their income, paddy cultivation was adopted by the villager with help of Govt. of Maharashtra. Changes in the

agricultural practices over the fragile slope, makes them more vulnerable to disaster. People in the Malin village had recently altered slope and converted them to terraces (Figure 19) at different levels for paddy cultivation which contributed to the instability of the slopes. Paddy cultivation at different level over the terraces practiced by the villagers of Malin (Figure 19) shown below using Google earth image.

Figure 19: Paddy cultivation over the terraces at different level clearly demarcated on Google earth image at village Malin

For paddy cultivation, large amount of water holding is required for long duration, which might percolated down and saturated the overburden material, jointed basaltic rocks intermittent with weak plane might have resulted into increased pore pressure along with the incessant rains accumulated for couple of days might have culminated into slope failure. The main problems of the Western Ghats region are the pressure of increasing population on land and vegetation, undesirable agricultural practices etc. These factors have contributed to ecological and environmental problems in the region.

Most of this area falls under the Eco-sensitive Area (ESA) as per the Kasturi Rangan Committee Report and Western Ghats and Ecologically Sensitive Zone I (ESZ I) as per Western Ghats Expect Ecology Panel Report. The fragile eco-system of the hills has come under severe pressure because of submersion of large areas under river-valley projects, damage to areas due to mining, denudation of forest, clear felling of natural forests for raising commercial plantation, soil erosion leading to silting of reservoirs and reduction in their life span and the adverse effects of floods and landslides, encroachment of forest land and poaching of

wild life etc. Multiple purpose dams in the tribal belt of Western Ghats were constructed in the Eco-sensitive area (**Sandrp, 2013**).

Evidences of the landslide events prior to 1967 indicate that problem of land sliding was not so intense in the Western Ghats. The Western Ghats Development Programme (WGDP), initiated during 1974-75 as centrally sponsored programme with full assistance from the Central Government, aimed at the accelerated development of the Western Ghats region comprising the states of Karnataka, Kerala, Maharashtra and Tamil Nadu as well as the union Territory of Goa, Daman and Diu with a view to bring them at par with the adjoining developed areas. The High Level Committee, consisting of the Chief Ministers of the concerned States and chaired by the Chief Minister of Maharashtra, emphasized programmes in the key sectors of agriculture, animal husbandry, forestry, dairy development, minor irrigation, soil conservation and roads. Various Schemes were taken up in the West Ghat with a view to improve the economic well-being of the local people and to exploit the resources of the region (**IGIDR, 2006**).

The delineation of the Western Ghats Region for inclusion in the Programme was settled in1981 by a one-man Committee headed by Dr. M.S. Swaminathan, the then Member-In-charge of the Hill Areas in the Planning Commission. For delineation of the areas for coverage by the WGDP, the criteria of elevation (600 m above MSL) and contiguity with taluka was adopted. The Programme is being implemented in 159 Talukas comprising of Western Ghats in five States viz. Maharashtra (62 talukas), Karnataka (40 talukas), Kerala (29 talukas), Tamil Nadu (25 talukas) and Goa (3 talukas).

The construction of farm ponds in Coorg was more useful as an irrigation work than as a soil conservation measure. Whereas amalgamation of paddy fields helped efficient cultivation, bench terracing, which was employment intensive, enabled cultivation of wasteland, besides conservation of top soil (**MoEF, 2011 and MoEF, 2013**).

The Padkai scheme (Figure 20) involves making steps on the mountain slopes and compressing the land. Machinery has been used to cut portions of the hills to make small plots for rice cultivation under this scheme. Since 2010, making of padkai fields has been incorporated under Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA), and it has also been taken up as a project worth Rs 45 crore by the tribal welfare department (**Indian Express, 2014**).

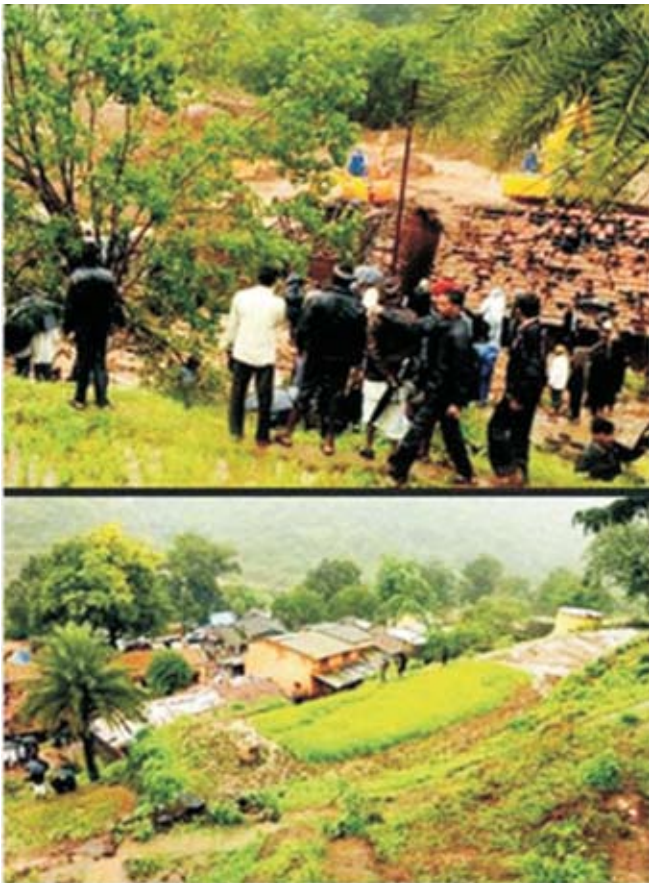

Figure 20: Padkai scheme in Malin (Source: Pune Miror, 2014)

Padkai scheme was introduced in three talukas of Pune district i.e. Ambegaon, Junnar and Khed. The scheme was introduced in Malin village during 2011-12 for the purpose of creation of cultivable plots for agriculture. For this development purpose, machines like JCBs were used to flatten the land and create cultivable plots in the upper part of village by altering original slopes (**ToI, 2014**). Near about 30 tribal farmers benefited from the scheme in 2011-12. Rs 4.75 lakh was spent during the financial year and about 2.57 hectares of land was cultivated. About 62 farmers benefited in 2012-13, Rs 7.34 lakh was spent and 3.70 hectares of land was cultivated. About 14 farmers benefited in 2013-14, Rs 2.39 lakh was spent and 1.09 hectares of land was cultivated (**ToI, 2014**). Under the above scheme, the rice cultivation activities started in the Malin village (Figure 21) since the year 2011.

Figure 21: Rice cultivation after flattening slope carried out at Malin village (Field photo collected during field visit (2-4 August, 2014)

Construction of road in the area led to destabilization of slope due to utilization of heavy earth moving equipment, JCBs etc. The roads have been constructed under the scheme of Pradhan Mantri Gram Sadak Yojana (PMGSY) and Western Ghats Development Progamme (WGDP) in Maharashtra included improvements in Ratangiri-Kolhapur road (State Highway No:49) in both the selected districts i.e. Kolhapur and Ratangiri. The rural road near Malin village has been constructed under the above schemes (Figure 22) (**MoEF, 2011 and MoEF 2013**). In the recent years, some of the major landscape changes occurring in this region are through mechanized terracing of slopes for cultivation as well as developments related to windmill projects on mountain tops, which entail deforestation as well as road cutting on steep slopes.

Figure 22: Road constructed under the various schemes at Malin village

Dimbe Dam was constructed under the Kukadi Major Irrigation Project JI00460 (NRSC, India-WRIS). It is a storage type dam, primarily used for irrigation purpose. From the Dimbe Left Bank Canal (DLBC), it can irrigate an area of 2,631ha with 107% intensity of irrigation, the potential is 2,815 ha whereas, the Dimbe Right Bank Canal (DRBC) can irrigate an area of 14,549 ha with 107% intensity of irrigation, and the potential of this canal is 15,568 ha.

The Malin village is situated approximately 1.5 km from backwaters of the Dimbe Dam (Figure 23), which is constructed as a part of an irrigation project involving a big dam completed in 2000.On the 31 July, the dam held 44% of its live storage which is about 156 MCM (Million Cubic Meters) of water. It is well documented that the dams can induce such landslides around the reservoir rim due to standing water with fluctuating levels, change in drainage pattern and underground water flow pattern (**Sandrp, 2014**).

Figure 23: Google map showing Dimbe Dam and location of Malin village close to the backwaters

Socio-Economic Impacts:

In this tragedy, about 146 people killed in the mud slide, of which 59 were males, 87 were females. Apart from this, 10 different body parts were also recovered, which were counted as 05 dead bodies by the doctors at the PHC. Total dead bodies recovered from the incident site were 151. Livestock, domestic animal is an integral part of village people in the study. Their livelihood also depends on livestock. In this tragic event, 58 animals died under the debris (NDRF, 2014).

The assessment of physical damage and impact was carried out by the State Government in various sectors i.e. housing, public buildings, roads, infrastructures, livelihood (agriculture & livestock). Some of the photos (Figure 24) showing the complete damage to house at Malin village. As per the record of

Ambegaon Taluka office, the total number of houses in main Malin village was 109 which include Govt./Public/Private property.

Due to the impact of the landslide, many houses in the village were partially damaged (Figure 24) and cracks developed due to debris slide. People living in the vicinity area were evacuated and shifted to safer place.

Figure 24: Complete Damage to houses due to movement of debris material

Most of village completely devastated. However, the remaining 24 house of the village were saved from devastation. 151 out of 181 people (i.e. 83% of the total population in main Malin village) got killed in the unprecedented event. The survivors lost their belongings, near & dear ones and houses. The psychological and panic created by this disaster left the surviving population paralyzed and helpless (NDRF, 2014).

Discussions:

The main problems of the Western Ghats region are the pressure of increasing population on land and vegetation, undesirable agricultural practices etc. These factors have contributed to ecological and environmental problems in the region. The fragile eco-system of the hills has come under severe pressure because of submersion of large areas under river valley projects, damage to areas due to mining, denudation of forest, clear felling of natural forests for raising commercial plantation, soil erosion leading to silting of reservoirs and

reduction in their life span and the adverse effects of floods and landslides, encroachment of forest land and poaching of wild life etc.

Land use changes in the Western Ghats over the last century caused by agricultural expansion, conversion to plantations and infrastructural projects have resulted in the loss of forests and grasslands. While the land use change remains the major threat to Western Ghats biodiversity, the intensive harvesting of non-timber forest products such as fuel wood, bark, leaves, fruits, exudates etc. has also contributed to loss of biodiversity and forest cover. Forest product contributes significantly to local household income. Overexploitation of resource affected the livelihoods of the users and main driver of deforestation. It is now desirable to have large scale afforestation in the entire region involving the community under participatory mode.

The stability of a slope can be decreased by increasing the pore water pressure in the soil through drainage. The laterite capped clayey materials are densely soaked in water due to persistent rains. The basic character of the clays allows them to absorb water easily into their inter-granular pore spaces. However, the inherent nature of poor permeability prevents them from discharging the excess water held in the pore-spaces. The excessive pore-water pressure in the clayey material when crosses the optimum limit leads to disruption of unstable scarp slope leading to the slope failure and massive landslide.

The volume of the slope failed material is based on the length and width data of each zone (i.e. zone-2, zone-3, and zone-4) of the landslide, was measured and the total volume is about 70,877 m^3. The height of the landslide is roughly 190 m while the width of the slide varies from 45 m to 134 m. The entire length of the slide from the crown to toe is 514 m. The crown of the landslide is at elevation 936 m which marks the top of the 4th slope zone. The width of the landslide in this zone ranges from 45 m to 62 m. The entire landslide affected area is 44,245 sq m (**GSI, 2014**).

Conclusions:

Rainfall records show that in the previous monsoon, i.e. in the year 2013 even higher rainfall took place than the rainfall in the year 2014. Surprisingly, there was no landslide at Malin hill slope then. It is anticipated that some moderation or changes might have taken place in the Malin village portion of the hill-slope between the monsoons of 2013 and 2014. The cause of triggering of the slope failure by a rock slide from the jointed basalt exposed in the crown area. The creation of gullies, contemporaneous to the sliding event, through which water was flowing even after three weeks of the occurrence of the tragic event, supports such contemplation.

High rainfall (108.5 mm, Dimbe rain gauge station, 9 km away from slide) during the preceding 24 hours must have played a crucial role in destabilizing the slope. Antecedent rainfall and stagnation of water due to agricultural terrace may have help in saturating the slope forming material. About 1.5 to 6 m thick surface forming material (silty clay with minor quantity of rock fragments) appears to have become oversaturated beyond liquid limit and the mass came down the slope as a debris flow.

Conduit capacity of the pre-existing natural drainage system on the hill slope could not cater to the high rainfall. The heavy rain water prior to the event was percolated either through interface of rock and soil or through the major joints and reduced strength parameters which resulted into the landslide. Moreover, the topography at the top of the hill perhaps led to the convergence of water in the slide area, which appears to be the main reason of the slide.

The other factor responsible for the landslides in the village was due to the development programme i.e. Padkai scheme of Government which basically is providing plots to the resident for farming purposes with terracing the hill slopes.

The Malin area is bounded in the northwest and southeast by ENE–WSW sinistral faults and in the northeast and southwest by NW–SE dextral faults. As the tectonics of the Malin area is controlled by ENE–WSW to NE–SW sinistral and NW–SE dextral faults, the input of regional tectonics over the Malin area cannot be ruled out. Hence, the Malin block must be under the grip of the stresses from the above traverse faults. Further, as these sinistral and dextral faults indicate the possible NNE–SSW compressive force, deformation must be occurring within the Malin block following the wrench fault tectonics. Wrench faults related tectonics must be opening up the fractures, the aggressively ongoing anthropogenic activities in the form of deforestation and cultivation, benching and intensive paddy cultivation along the softer hill slopes, disturbance of toes in the down slope parts of Malin village and heavy impounding of water in such bench cultivated paddy fields have contributed to the increase of pore pressure resulted in mud flows. Thus, Malin landslides are the culmination of tectonism, accumulated rainfall and anthropogenic activities.

Key Recommendations:

The following recommendations suggested:

- Identification of landslide Risk zonation in the area is very essential and appropriate Risk Reduction Measures strategy may be implemented after consultation with various scientific societies along with local communities. As anthropogenic intervention increased during past decades in the Western

Ghats which and the area is considered as ecologically very sensitive area, it is essential to carry out detail landslide inventory & susceptibility mapping.

- As the area is geologically very fragile and environmentally degraded, mainstreaming of landslide disaster risk reduction into Developmental framework may be viable option for safe hill area development in the region. As the area falls under Eco-sensitive zones, appropriate policy may be designed so as to minimize the environmental damage and may promote sustainable development in the region in order to reduce the risk of landslide in future.

- The area falls under heavy rainfall zone and is vulnerable to landslide for many decades. There is no early warning for landslide in this region. Early warning is an important component of preparedness to mitigate the disaster. Hence, it may be desirable to establish well connected rain gauge stations and Doppler radar for development of early warning for landslide based on robust system of weather foresting. Early warning system and dissemination of information among the vulnerable community may be helpful in mitigating the impact of disaster.

- The area is devoid of real time automated monitoring of landslide parameters such as movements, development of stress, measurement of pore pressure, installation of sensors through instrumentation. This may help in getting information and time of occurrence and impending danger of landslide. Based on Early warnings, alerts can be issued to the likely affected community for better preparedness and relocation to safer place prior to disaster. In many cases of disasters, early warnings played a very crucial role in saving precious human lives.

- There was no telecommunication system in the area. For better management and preparedness, communication system to be developed and priority to given to those vulnerable areas.

- Public awareness is equally important to reduce the impact of landslide disaster. Mostly disaster is a local event. Whenever disaster occurs, community always plays very crucial role as first responder. Initial first hour after the disaster is basically the golden hours for the responders to respond to disaster. Chances of survival of the victims' lives are more during the golden hours. Hence, the training of community is utmost important. By the time, the government machinery respond to disaster, the chances of survival of victims gradually decrease because of many factors such as distance, transportation time, availability of access road etc. In the Malin landslide, there was perhaps no community awareness regarding landslide

disaster. They have not experienced such landslide in the preceding years. Regular mock drill and community based awareness programme related to disasters helps in better preparedness and better understanding.

- Most of the landslides occur during the monsoon. Pore pressure plays a major role in initiating landslide events. Hence, surface and sub-surface water management on the slopes is the most effective remediation measure for controlling many landslides. Management of surface runoff and sub-surface water is done through the construction of drainage networks. At Malin village, appropriate specific site solutions are needs to be provided in order to avoid future slides.

- As the area is Geologically, Geo-technically and ecologically very fragile, during construction of roads and irrigation canals, proper care must be taken to avoid blockage of natural drainage.

- Various non-structural measures such as proper land use regulations and building codes based on scientific research. The house should be made of brick and cement as there is minor crack observed in buildings near the school and there were no cracks in school buildings. The Poor construction of house may lead to more casualties.

- Afforestation program should be properly planned. Selection of suitable plant species should be such which can tolerate the existing stress conditions of the terrain.

- Some basic information about safety tips for landslide prone areas may be posted and distributed among the public in such places.

- Paddy cultivation towards up slope and down slope of populated hill slope is not advisable. Crops which do not require saturated soil or stagnation of water may be alternative viable options. Agricultural scientist may have to be consulted for choosing the crop or plantation type.

- Any moderation on hill slope, especially the destabilization of which may lead to intolerable loss should be geo-technically assessed prior to moderation and changes in land use pattern. Records should be kept for all moderations and changes in land use pattern of any hill-slope.

- As the area is environmental degraded, vegetation cover over the slope may be helpful in controlling and mitigating landslide hazard to great extent by bio-engineering technology. Hence, selection of appropriate plant species may be consulted with the experts and mass scale afforestation may be implemented involving the local communities.

- Any developmental activity initiated in the area should be taken up only after a detailed study of the region and slope protection and should be provided under the guidance of competent authority.
- Insurance play crucial role in risk reduction mechanism can be used as a tool towards landslide risk mitigation. Landslide costs include both direct and indirect loss that affects public and private properties. Purchasing insurance is a way to reduce the financial impact of a business interruption, loss or damage of property or building etc. Insurance companies provide coverage for property damage, business interruption, loss of livelihoods, business and many other losses. Purchasing of Insurance in the vulnerable areas may be wise decision that may be promoted through awareness campaign at community level.

References:

1. Bhandari, R. K., 2014. The Malin mud avalanche tragedy of 30 July 2014 – time to ask the right questions. Current Science, Volume 107, No. 4, August 2014. http://www.currentscience.ac.in/Volumes/107/04/0560.pdf
2. Census of India, 2011. http://censusindia.gov.in/2011census/censusinfodashboard/stock/profiles/en/IND027_Maharashtra.pdf
3. Density of Population in India 1901-2011. http://www.medindia.net/health_statistics/general/populationdensity.asp
4. ENVIS, 2013. Population and its Growth, India: 1901-2011. ENVIS Centre on Population and Environment. http://www.iipsenvis.nic.in/Database/Population_4074.aspx
5. Forest Department Report, 2013.A statistical outline current salient forest statistics 2013. Forest Department, Government of Maharashtra.http://www.indiaenvironmentportal.org.in/files/file/maharashtra%20forest%20statistics%202013.pdf
6. Frontline, 2012.Integrated Study needed for Ghats- Interview with Professor Madhav Gadgil, Chairperson of the Western Ghats Ecology Expert Panel. Frontline Magazine, volume 29, Issue No. 15, 28 July -10 August, 2012.http://www.frontline.in/static/html/fl2915/stories/20120810291508500.htm
7. Gujarathi, Pooja and Mane, S. J., (2015).Landslides Zones of Nearby Areas of Malin Village, Pune District, Maharashtra Using GIS Techniques. International Journal of Science and Research (IJSR), Volume 4, Issue 7, July 2015. http://www.ijsr.net/archive/v4i7/SUB156358.pdf
8. Govt. of Maharashtra, 2015.Economic Survey of Maharashtra 2014-15.Directorate of Economics and Statistics, Planning Department, Government of Maharashtra, 17 March, 2015. https://www.maharashtra.gov.in/Site/upload/WhatsNew/Economic%20Survey%20of%20Maharashtra...pdf

9. Govt. of India, Census 2011.Village/Town-wise Primary Census Abstract, 2011 - Pune District of Maharashtra.https://data.gov.in/catalog/villagetown-wise-primary-census-abstract-2011-maharashtra#web_catalog_tabs_block_10

10. Indian Express, 2014. Heavy machinery created farms in vulnerable zone, E-News, dated 1 August, 2014. http://indianexpress.com/article/india/india-others/heavy-machinery-created-farms-in-vulnerable-zone/

11. IGIDR, 2006. State of Environment Report: Maharashtra (Final Draft Report). Indira Gandhi Institute of Development Research, Mumbai. http://www.moef.nic.in/soer/state/SoE%20report%20of%20Maharashtra.pdf

12. Kumar, M. Ravi and Bhatia, S. C., (1999).A new seismic hazard map for the Indian plate region under the global seismic hazard assessment programme.Current Science, Vol. 77, No. 3, 10 August, 1999. http://www.currentscience.ac.in/Downloads/article_id_077_03_0447_0453_0.pdf

13. Kohli, A., Bhandari, A., Singh, Yogendra, (2014). A report on "An appraisal of Malin Landslide, District Pune, Maharashtra and reconnoitory assessment of vulnerable zones around Malin village" (Toposheet No. 47E/12, Mission-IV/Field Season: 2014-15). Geological Survey of India, Centre Region, Pune, November, 2014.

14. MoEF, 2011. Report of the WGEEP. Report of the Western Ghats Ecology Expert Panel, submitted to the MoEFCC, 31 August 2011. Eds. Prof. MadhavGadgil, Chairman, Western Ghats Ecology Expert Panel.http://www.moef.nic.in/downloads/public-information/wg-23052012.pdf

15. MoEF, 2013. High Level Working Group Report, part-I, 2013.Report of the High Level Working Group on Western Ghats, Volume I.http://www.indiaenvironmentportal.org.in/files/file/HLWG-Report-Part-1.pdf

16. MoEF, 2013. High Level Working Group Report, part-II, 2013. Report of the High Level Working Group on Western Ghats, Volume II.http://www.indiaenvironmentportal.org.in/files/file/HLWG-Report-Part-2.pdf

17. Mungekar, Bhalchandra, 2009. Third report of the Standing committee of Inter-Sectoral Issues Relating to Tribal Development on Standards of Administration and Governance in the Scheduled Areas.Member, Planning Commission, Ministry of TribalAffairs, Government of India, New Delhi.http://hlc.tribal.nic.in/WriteReadData/userfiles/file/Mungekar%203rrd%20report.pdf

18. Nadim, F., Kjekstad, O., Peduzzi, C. Herold, Jaedicke, C., 2006. Global landslide and avalanche hotspots. Springer, May 2006, Vol. 3, Issue 2, pp 159-173. http://link.springer.com/article/10.1007%2Fs10346-006-0036-1

19. NDMA, 2009. National Disaster Management Guidelines – Management of landslides and snow avalanches. National Disaster Management Authority, New Delhi. http://www.ndma.gov.in/images/guidelines/landslidessnowavalanches.pdf

20. NDRF, 2014. Detail report of search and rescue operation conducted in landslide at village Malin Gaon, tehsil Ambegaon, district Pune, Maharashtra. Letter ref No. I-17018/1605/Ops/HQ DG-NDRF/2014/9750, dated 8 September, 2014

21. NRSC, India-WRIS, Water Resources Information System of India. Dimbe D02966.http://india-wris.nrsc.gov.in/wrpinfo/index.php?title=Dimbe_D02966

22. Parkash, Surya (2012). Comprehensive Landslides Risk Management: Training Module. http://nidm.gov.in/PDF/modules/Landslide.pdf

23. Patil, Sanjay, 2013. Impact of irrigation on agriculture in Pune district.INCON13-GEN-099.ASM's International E-Journal of Ongoing Research in Management and IT e-ISSN-2320-0065. http://www.asmgroup.edu.in/incon/publication/incon13-gen-099.pdf

24. Petley, Dave, (2014). Malin landslide in Pune, India: a mass fatality mudslide yesterday, dated 31 July, 2014. http://blogs.agu.org/landslideblog/2014/07/31/malin-landslide-1/

25. Pune Mirror, 2014. Agridept bans machines for Padkai - Pune Mirror. E-News, dated Sep 3, 2014. http://www.punemirror.in/pune/civic/Agri-dept-bans-machines-for-Padkai/articleshow/41545043.cms

26. Pune Mirror, 2015. Shadows lies over Padkai scheme this year. E-News, dated 17 February, 2015. http://www.punemirror.in/pune/civic/Shadow-lies-over-Padkai-scheme-this-year/articleshow/46266446.cms

27. Ramachandra, T. V., Subash Chandran, M. D.., Joshi, N. V., Pallav, Julka, B., H. Aithal, Prakash, M., Rao, G. R. and Vishnu, M., 2012.Landslide susceptibility zone mapping in Uttara Kannada, Central Western Ghats. Sahyadri Conservation Series-7, ENVIS Technical Report: 28 February 2012. http://wgbis.ces.iisc.ernet.in/biodiversity/pubs/ETR/ETR28/section4.htm

28. Ramachandra, T. V., Kumar Uttam and Aithal, Bharath H.., 2010. Landslide Susceptible Locations in Western Ghats: Prediction through Open Modeller. 26th Annual in-house Symposium on Space Science and Technology, ISRO-IISc Space Technology Cell, Indian Institute of Science Bangalore, 28-29 January 2010. http://www.researchgate.net/publication/256838741_Landslide_Susceptible_Locations_in_Western_Ghats_Prediction_through_OpenModeller

29. Ramasamy, S. M., Muthukumar, M. and Subagunasekar, M., (2015). Malin–Maharashtra landslides: a disaster triggered by tectonics and anthropogenic phenomenon. Scientific Correspondence, Current Science, Vol. 108, No. 8, 25 April, 2015. http://www.currentscience.ac.in/Volumes/108/08/1428.pdf

30. Sandrp (2013). Multiple Dams in Tribal Belt of Western Ghats for the Mumbai Metropolitan region: Unjustified projects, when better options exist, draft report. http://sandrp.in/Mumbai_Dams_Draft_Report_Dec_2013.pdf

31. Sandrp, 2014. Malin Landslide tragedy underlines the vulnerability of Western Ghats., dated 1 August, 2014. https://sandrp.wordpress.com/2014/08/01/malin-landslide-tragedy-says-how-vulnerable-are-western-ghats

32. Shodh Ganga, Profile of the Study area: Pune District. http://shodhganga.inflibnet.ac.in:8080/jspui/bitstream/10603/5658/11/11_chapter%206.pdf

33. Sassa, Kyoji; Rouhban, Badaoui; Briceño,Sálvano; McSaveney, Mauriand He, Bin (2013). Landslides: Global Risk Preparedness. Springer.

34. Shi, Peijun and Kasperson, Roger; 2015.World Atlas of Natural Disaster Risk, IHDP/ Future Earth-Integrated Risk Governance Project Series. BNUP and Springer. http://www.springer.com/series/13536)

35. ToI, 2014.Padkai scheme in Malin on since 2011-12, documents reveal. E-news, Times Of India, dated 4 August, 2014. http://timesofindia.indiatimes.com/city/pune/Padkai-scheme-in-Malin-on-since-2011-12-documents-reveal/articleshow/39580053.cms

36. ToI, 2014.More landslides likely in 5 km radius of Dimbhe dam. E-news, Times of India, dated 30 July, 2014. http://timesofindia.indiatimes.com/City/Mumbai/More-landslides-likely-in-5km-radius-of-Dimbhe-dam/articleshow/39314716.cms

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Learning from Community on Recovery Management in the Aftermath of Gujarat Earthquake

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Abstract:

This study examines decisions and actions taken for rehabilitation and reconstruction just after 2001 Gujarat Earthquake with special focus on local perception of the government response to the earthquake, community involvement in reconstruction process, the priority of the government for rebuilding and futuristic measures adopted for disaster risk reduction management. The study is based on the data collected through face-to-face meetings with the households and group discussions with the community leaders. The findings indicate that community leaders and individuals were largely satisfied with the entire process. Although some time was lost in planning, yet the recovery was well executed. The people were involved in rebuilding of their houses; however there was little dissatisfaction towards funding. The coordination between non-governmental and governmental organizations was designed properly. The communities were largely satisfied as soon as they could resume their livelihood and their children went to schools, which were the essential focal areas of the recovery management. The paper concludes the dire need of having a well-thought recovery framework at the national, state and community level which could be practiced for optimal recovery management.

Keywords: *Earthquake, Disaster Management, Disaster Risk Reduction, Reconstruction Program, Recovery Management and Sustainable Development.*

1. Introduction

The Kutch Earthquake of 7.7 M was one of the worst natural disasters to strike in India on 26th January 2001. The epicenter was about 9 km south-southwest of the village of Chobari in Bhachau Taluka of Kutch District of Gujarat, India[1]. Overall, a vast geographical area of 7633 villages in 21 (out of 25) districts of Gujarat, was affected to varying degrees. Almost 13,805 human lives were lost, about 166,836 persons were injured and approximately 339,000 buildings destroyed and 783,000 damaged in Bhuj-Ahmadabad-Rajkot area[2.] Apart from two district hospitals, over 1,200 health clinics (mostly in rural areas) were destroyed. Over 11,600 schools both in rural and urban areas were destroyed or damaged. Over 240 earthen dams for small reservoirs providing water for irrigation, rural and urban domestic needs, and industry were also damaged. Other infrastructure services like electricity, telecommunications and roads were extensively

damaged including thousands of small and medium production units which went out of production, affecting income and employment.[3] Because of its magnitude, intensity and geographical spread, it posed enormous challenges for rescue, relief and rehabilitation.

Analysis of the recovery management of the Gujarat Earthquake provides a crucial case study as the state government undertook an innovative approach to disaster recovery management with decision making and institutional setup evolved over time. In spite of the immediate sense of shock, helplessness and grief, the government and the community rose to the occasion and responded with vigour to the event. A holistic and comprehensive reconstruction and rehabilitation program was put in place by the newly established organization, named as Gujarat State Disaster Management Authority.

The Gujarat Earthquake Reconstruction Program was designed to address the needs of the affected people through build-back-better approach. It involved the community and encompassed sectors such as housing, physical infrastructure, social infrastructure (education and health), urban reconstruction, livelihood restoration, social rehabilitation and long-term disaster risk reduction. The objective of the program was to promote sustainable recovery in disaster affected areas and to lay down foundation for sustainable disaster management capacity in Gujarat. The program was implemented in three phases viz. short-term, medium-term and long-term. The short-term phase was designed to address the immediate needs such as arrangements of temporary shelters before the onset of the monsoon, debris removal, repair of houses and public buildings and emergency repair of irrigation structures. The medium-term phase emphasized upon reconstruction of houses, public and social infrastructure, systematic disaster mitigation and risk reduction. The long-term phase continued towards strengthening the capacity of government institutions and community towards disaster risk reduction and implementation of risk transfer mechanism.

The study aims to understand the recovery process and the perception of community on the impact of recovery management in their lives. The paper identifies the gaps and issues based on the analysis of surveyed population of 123 households of the worst affected villages in Gujarat and several group discussions held with the community leaders. It suggests preparation and implementation of recovery management framework to build capacities of the government, stakeholders and communities in advance so that the recovery measures could be implemented systematically and timely after the disaster.

2. Methodology

The household survey was carried out to understand the challenges that existed on ground after a post-earthquake situation as well as expectations of

the community at large from government and other organizations. One of the objectives of the survey was also to find out various good practices implemented on ground to ensure a speedy and effective recovery process. The Survey and Focused Group Discussion (FGDs) were carried out in Kutch and Morbi districts in relocation sites namely Pramukh Swami Nagar, Ravalwadi in old Bhuj city, Anjar Town, Kukma village of Bhuj Block and Morbi city in Morbi district.

A questionnaire was developed to collect information at the household level (123 no). Along with it, four FGDs were conducted in the survey sites which helped in validating the information collected at the household level as well as also to get additional information from major stakeholders. The questionnaire for household survey had five sections for capturing information in the areas of impacts on lives and assets, impact on income and livelihood, immediate actions taken by the Government, measures taken by the government during short-term, medium term and long-term phases of recovery and redevelopment. The data was authenticated and tabulated for focused analysis. A set of questionnaire was also developed for conducting the FGDs with community leaders including teachers, local government and representatives of social organizations.

3. Government Approach

The Government of Gujarat had adopted holistic approach to disaster management formulating a comprehensive reconstruction and rehabilitation program with focus on risk reduction based on hazard, vulnerability and risk analysis. The program covered housing, health, education, livelihood, public infrastructure, social rehabilitation, urban infrastructure and disaster risk management through good governance. The program was designed to ensure long-term disaster resilient development through sustainable disaster risk reduction. Based on damage and needs assessment, a comprehensive program for reconstruction and rehabilitation was designed and implemented covering several sectors. Salient features of the Program are as under:

- Owner-Driven Approach: The reconstruction of the houses was primarily done by the owners themselves with the financial and material assistance provided by the state government.
- Technical Assistance for earthquake resilient Structures: A large number of engineers, architects and masons were trained on hazard resilient construction techniques. Technical modules and guidelines were developed. A third-party audit mechanism was established to control quality. Regulatory system for safe construction was strengthened and licensing of engineers and certification of masons were introduced.
- Risk Insurance: The Housing Insurance Programme was incorporated as a compulsory component for all G+5 houses and optional for houses of other

categories. The insurance covered 14 types of risks for 10 years and the premium was fixed at about US$ 10 for an insured sum of about US $2500.

- Improved Urban Planning: The towns affected in the earthquake were developed based on the sound urban planning principles with improvement of basic services and environment.
- Community Preparedness: Mass awareness on disaster preparedness was undertaken to prepare the community to handle similar eventuality in future.

The sector wise details are as under:

3.1 *Housing*

The program was considered as one of the largest housing construction program in the country in terms of numbers of houses constructed and geographical area covered with risk insurance and joint ownership built in. The State Government adopted owner's driven approach as well as public-private partnership. Relocation sites were selected after due consultation with the village community. The release of payment for construction was made in three instalments subject to verification and certification. Trained masons and engineers were appointed to supervise the construction work and to provide technical assistance.

3.2 Health Services

To bring the health system back on its footing, the temporary health camps and hospitals were established and alternative arrangement was made to prevent epidemic outbreak. Financial assistance was provided to the disabled and injured. A super-specialty hospital with base isolation technology was constructed at a cost of US $25 million. Other health facilities were also repaired and restored with the inclusion of multi-hazard resistant technology.

3.3 Educational Facilities

The Government of Gujarat, with donor's assistance, started schools in temporary shelters within 3 months in order to save academic year of thousands of children. The Primary schools were reconstructed on priority with multi-hazard resistant technology. The school syllabus was revised to include lessons on disaster preparedness and response at all levels.

3.4 Public Infrastructure

All the infrastructure facilities and public buildings were made multi-hazard resistant to withstand future disasters. Rainwater harvesting was an essential

feature in all the projects of the police housing. Retrofitting and restoration was taken up for ensuring safety of roads, dams, water supply system and other public infrastructure as per Indian Standards Codes (IS) on earthquake resistant features. Third party Quality Assurance and Technical Audit were conducted for repair and construction.

3.5 Social Rehabilitation

The Government of Gujarat had rehabilitated the orphans, widows, aged and handicapped persons by providing financial assistance, compensation, residential facilities, provision for children education and skill up gradation, medical aid and counseling. A surveillance mechanism was established with the help of UNICEF and other NGOs to keep a regular check on well being of orphans. Three Old Age Homes were made functional in Bhuj, Bhachau and Anjar.

3.6 Urban Infrastructure

The Area Development Authorities were constituted in the affected towns to ensure compliance to the building codes for safety. The General Development Control regulations were amended to incorporate IS codes for seismic and cyclone safety. The development plans were prepared for the towns of Bhuj, Bhachau, Anjar and Rapar in the Kutch district including town planning schemes. The redevelopment of Bhuj town is one of the finest examples of build back better approach.

3.7 Community Participation

Through information campaigns, advertisement, video shows and booklets, all the stakeholders were informed about various assistance packages declared by the government and procedures for availing the assistance. Various communication channels were used to create awareness on multi-hazard resistant construction.

3.8 Livelihood

The Government of Gujarat evolved a three-pronged approach for sustainable livelihood viz. immediate restoration of livelihood, enhancing the skills of artisans and empowering the artisans to market their skills. Livelihood packages were declared to address the needs of a wide range of people from agriculturalists to rural artisans. The farmers were provided with input kits, irrigation assets, and farm structures. Tool kits were distributed to artisans and handicraft artisans. Kiosk for shops and interest subsidy were given to service and trade units. The women were provided schemes for self-employment.

3.9 Setting up an Institutional and Legal Mechanism for Disaster Management

The Gujarat State Disaster Management Authority was created with a short-term objective for coordinating the reconstruction program and a long term vision for capacity building of all the stakeholders. The Gujarat State Disaster Management Act was enacted in 2003. The Disaster Management Plans were prepared at State and Districts level. A State Policy was formulated to ensure long-term initiatives for disaster management.

4. Findings from Household Survey

The surveyed households in Gujarat largely belong to tertiary sector (44 percent engaged in service and 28 percent in business). These respondents were severally affected by the earthquake. It is evident from the household survey that local governments were not capacitated enough to respond to such a catastrophic event and immediate service delivery like search and rescue, health and trauma care, restoration of water/electricity/sanitation and debris removal. This indicates the importance of capacity building of local government on immediate response to reduce the overall impact of the disaster and ensure faster recovery.

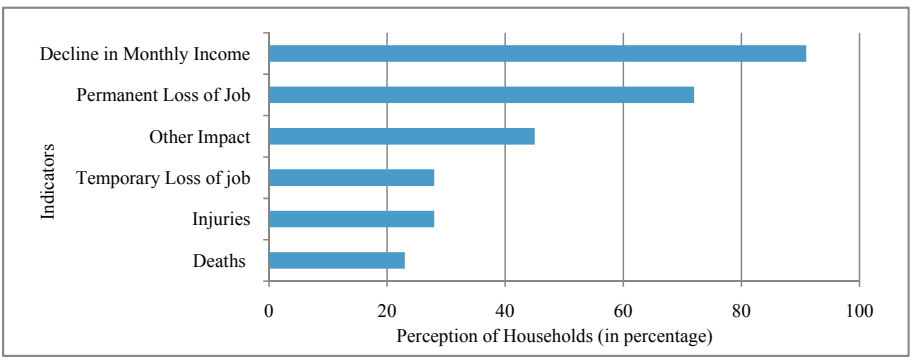

Fig. 1. Impact on Human Lives and Livelihoods

4.1 Impact on Human Lives and Livelihood

Fig.1. summarizes the impact of earthquake in general on 123 households surveyed. About 23 percent of the respondents stated that the disaster caused deaths in their family and 32 percent indicated severe injuries caused to the family including disability. About 72 percent lost their permanent jobs, while 28 percent lost their job temporarily. Overall, the earthquake resulted in decline in the monthly income of most of the households.

4.2 *Impact on Property and Household Assets*

Fig.2 illustrates impact of earthquake on household assets and property. The survey brings out that all the houses were devastated and damaged by the earthquake. The services such as water, electricity and sanitation were cut-off. Assets such as furniture, white goods, livestock, vehicles and other household items were also damaged.

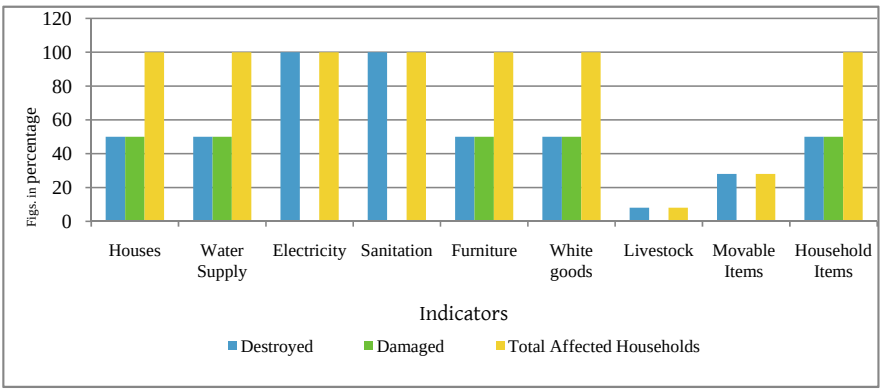

Fig. 2. Impact on Property and Household Infrastructure

4.3 *Immediate Measures*

The impact of the earthquake was such that the local government found it difficult to cope up with the situation. The delivery of immediate services such as supply of potable water, sanitation facilities, solid waste management, debris removal and maintenance of law and order could only start properly after 6 days. Fig. 3 depicts the immediate action taken by local government. About 50 percent of the households indicated that that search/rescue and evacuation operation could only start after 24 hours of the earthquake.

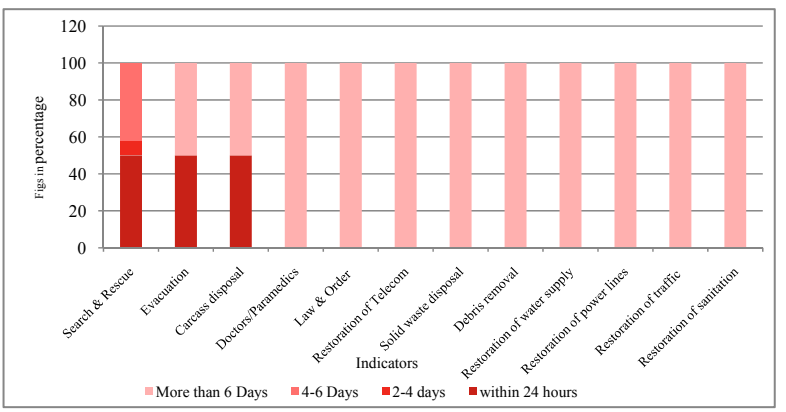

Fig.3. Immediate Measures by the Local Government

4.4 Short-term Measures

Restoration of social infrastructure like education and health facilities after the disaster helps the community to start with their normal activities faster. Similarly setting up of transient/temporary shelters help to access and live in a covered living space with security, safety, dignity and privacy. Hence, standard guidelines on restoration of social services as well as on design and maintenance of temporary shelters should be made available to the local government for better delivery. Table 1 indicates the response of the government to short-term measures such as food supply chain, temporary shelters, restoration of education, water, sanitation and solid waste disposal and heath & trauma counseling facilities.

4.4.1 Food supply

The survey brings out that the food supplied to the affected families was sufficient in quantity and nutritious for almost a month. The community based organizations and Non-Governmental Organisations played a very active role in distribution of food within 24 hours. Since the raw material was provided, the community kitchens were setup within the premises of relief shelters. However, special requirements of infants, pregnant and lactating women could not be adequately addressed.

4.4.2 Temporary shelters

Almost 99 percent of the respondents lost their houses due to earthquake and lived in temporary shelters for almost a year after the disaster. About 84 percent of the people found that the shelters had adequate space to accommodate their families whereas balance felt the need for more spacious shelters for joint and large families.

4.4.3 Water, Sanitation and Solid Waste Disposal

The basic services such as water and sanitation facilities were provided within the temporary shelters. Separate toilets were kept for women. However, almost all the respondents felt that the toilets were not regularly cleaned and were not hygienic. Almost all the respondent indicated that solid waste disposal system was not functioning, which was a continuous worry.

4.4.4 Education

The survey showed that there was considerable loss of instruction time as the school reopened three months after the earthquake. No arrangement for makeshift schools could be made and no educational material was distributed for the school children. Also it took more than 24 months to restore or reconstruct the damaged school buildings.

4.4.5 Health and Trauma Care

Similar to education, all the respondents said that delivery of health care services took a lot of time to reach to the affected community immediately. Although epidemics did not break out in both the districts, immediate delivery of health services like setting up of makeshift hospitals, deployment of doctors, nursing facilities, immunization of children, health care for lactating and pregnant women and psychosocial counseling could not be provided.

4.4.6 Restoration of Social Infrastructure

It was felt that standard guidelines on restoration of social services on design and maintenance of temporary shelters should be made available to the local government for better delivery of services. Community leaders stated that the government was proactive and coordinated with local administration, NGOs and community in relief distribution. The government undertook intense consultation with the community leaders and groups for search & rescue, provision of temporary shelters and restoration of basic services.

Table 1. Short-Term Measures

Indicators	Sub-Indicators	Households Agreed[4]
Food and Civil Supplies	Sufficient quantity of food items distributed	100
	Good Quality/Nutritious food	100
	Special arrangement for food for infants, pregnant women and lactating mothers	0
	Community kitchen setup	100
Shelters	Nos. of families lived in the temporary shelter	98
	Duration of the stay was more than 1 year	98
	Sufficient space provided to stay in temporary shelter	82
	Tents and blankets distributed were sufficient	49
	Nos. of families lived in their own house	02
	House was damaged	02
	Immediately repaired	02
Schools	Any makeshift schools established within 3 months	0
	Free course books and stationary distributed to the students	0
	More than 1 year taken to make school operational	100

Indicators	Sub-Indicators	Households Agreed[4]
Water, Sanitation and Solid Waste Disposal	Temporary toilets and bathrooms established immediately	99
	Maintained and cleaned regularly	01
	Separate toilets for women	100
	Drinking water was sufficient in the shelter	100
	Solid waste disposal system available	01
	Satisfied with the facility provided	91
Health and Psycho-social Counseling in three Months	Makeshift hospital	0
	Immunization facilities	0
	Special care for pregnant and lactating mothers	0
	Availability of critical medical support to elderly, sick and disabled	0
	Nurse, physicians, specialized doctors and other para-medical staff available within 24 hours of the disaster	0
	Timely medical attention provided	0
	Psycho-social first-aid provided	0

4.5 Medium Term Measures

Table 2 indicates that the households were satisfied with post-disaster activities such as damage and needs assessment, payment of ex-gratia, restoration of livelihoods, repair of school buildings and partially damaged houses, water supply, sanitation and electricity.

The households stated that the state government conducted systematic damage and needs assessment for assessing the level of damage of their houses and other assets as well as of various community infrastructure. Assessment of basic community needs like food, water and facilities for sanitation were also made. The ex-gratia was distributed timely by the government. The community leaders indicated the need for preparation of standard formats for conducting damage and needs assessment instead of designing these at the need of hour, which can save lot of valuable time.

The respondents said that adequate support was provided by the government to restore their primary livelihood, though they were not satisfied with the value of ex-gratia. They have also felt that the government could arrange for alternate livelihood options till their primary work was started. The respondents stated

[4] Figures are in percentage calculated from the household survey sample size of 123.

that they had to spend some of their own wealth to restore their houses, properties and assets.

Table 2. Medium Term Measures

Indicators	Sub-Indicators	Households Agreed3
Damage Assessment	Assessment of the damage to your house and other properties done	100
	More than 1 month taken for completing assessment	100
	Needs of water, health, sanitation, food and shelter were assessed	100
	Detailed damage assessment was conducted for all categories of assets (structural and non-structural); movable and immovable	100
Payment of Ex-gratia	Ex-gratia was paid for losses and damages	100
	Ex-gratia paid within 30 days	100
	Ex-gratia received was sufficient in lieu of the losses or damage	0
Repairs and Restoration	Supported by Government to restore primary livelihood	100
	Alternative opportunity provided until main work was restored	0
	Electricity, water supply and sanitation related facilities were fully repaired/restored in the village	100
	Schools, institutions, govt. buildings, and hospitals/primary health centers were fully restored	100
	Spent own money for repair/restore your house, properties and assets	97

4.6 *Long- term Measures*

Almost 87 percent of the houses were reconstructed at new sites with financial assistance provided by the Government. The material banks established by governments at Taluka/Block level helped the community to access to good quality building materials. Other community infrastructures like roads, culverts, bridges, schools and health centers had been constructed at the relocation sites. Overall, people were satisfied and happily resettled in the relocation sites. For restoration of livelihood, the government provided training to the local craftsmen and artisans to develop useful items by using local resources. The houses were designed based on socio-economic and cultural needs of the community besides providing earthquake

resistant construction. The social assets and infrastructure such as schools, hospitals, community centers, *Aanganwaris* and connecting roads were provided keeping local requirements and aesthetics of community in consideration. The house structures were designed as per the norms prescribed for Earthquake Zone V so that they could withstand the large intensity earthquake.

Although owner driven *in-situ* housing construction was the key feature of the Earthquake Reconstruction Program, relocation could be effective wherever community had decided to opt for it. It also reinforces the importance of community participation in "building back better" and emphasizes that community consensus should be a primary factor in determining whether to rebuild in-situ or relocate. Table 6 indicates the satisfaction derived by the community in reconstruction of houses.

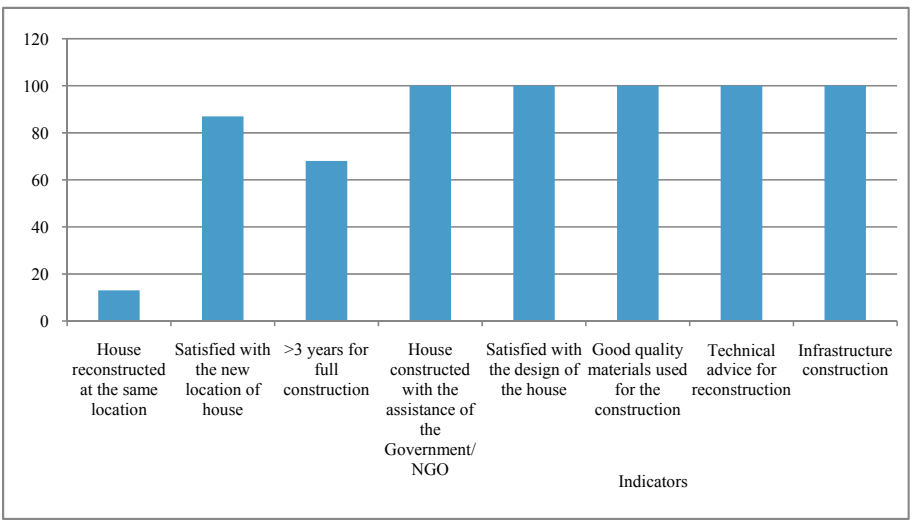

Fig 4. Reconstruction of Houses[6]

4.7 Perception of Community Leaders

Community leaders shared their experiences of rehabilitation and reconstruction after the earthquake. They talked about the housing, its quality of reconstruction and standardized norms for earthquake resistant buildings. The discussion with the community leaders led to certain concerns related to their future well being. Though the buildings and infrastructure were constructed by adopting earthquake resistant technology, they had their own doubts. The reasons have been attributed to lack of monitoring by the government agencies, violation of rules by the builders and lack of trained professionals such as engineers, supervisors and masons. The community leaders shared that most of the house owners who were provided insurance for their houses for ten years, did not renew it afterwards.

The leaders felt that flexibility and trust reposed by the Government on community based organizations had helped in better recovery post earthquake. Initially the Government response was impaired due to large-spread devastation, particularly in the district capital, Bhuj. The community members themselves mobilized the search and rescue operation in their neighborhood. The NGOs such as Self-Employed Women's Association (SEWA) and Kutch Navnirman Abhiyan helped people to restore their livelihoods and reconstruction. The State government encouraged partnership between international and local NGOs in order to leverage resources and understand relief needs.

The local leaders stated that the people of Gujarat, who had acquired sufficient knowledge and experience to handle such a large-scale disaster, now had strong institutional setup backed up by the trained professional, adequate resources and sensitized community. They are confident to manage such disasters with the help of pre-identified State Disaster Management Agencies, their roles and responsibilities, concerned officials, NGOs and community. They shared that the Gujarat Disaster Management Authority and sub-district administration had circulated guidelines to conduct mock drills on different disasters to fine-tune the preparedness of the administration and local community. The local groups stated that constant monitoring and evaluation were required for a successful recovery program. Setting up of effective coordination mechanism for relief, recovery and reconstruction should be emphasized. Inventorisation of database of NGOs and community based organizations according to their competence should be done beforehand. Local Panchayat needs to be actively engaged in decision making process of recovery.

The local community feels that the focus should be on adequate preparedness for response and long term recovery planning and management. There is a need to develop comprehensive guidelines for damage and loss database for planning and execution of any disaster reconstruction management. Standard guidelines for facilitating better coordination among stakeholders should be developed. Sustainable natural resource management and livelihood restoration program are vital for recovery management. Rebuilding of schools, health centers and housing should be given priority in any recovery program. The traditional knowledge of the community should be harnessed and capacity of the community may be further strengthened to build their skill set. The local professionals such as engineers, teachers, builders and supervisors should be deployed in risk assessment, construction and monitoring, which could also address the issue of provision of alternate livelihood. It is with this background that we reach to an understanding of the need for a sustainable recovery management framework to deal with disasters effectively.

5. Issues and Gaps

The analysis of the data indicates that though the state government with the support of national, international and community organizations could take up stupendous task of implementing the reconstruction program, a lot of time had to be spent in planning and execution. Although it is difficult to evaluate the entire reconstruction process through a limited sample size, certain issues and gaps could be significantly observed and are as under:

- *Immediate response:* The local government itself is not capacitated enough to respond to such a large-scale disaster. This causes delay in immediate actions for search and rescue, temporary shelters, health and trauma care, debris removal, restoration of electricity, water supply and sanitation facilities.

- *Availability of food:* The special requirement of food for children, infants and pregnant or lactating women needs to be addressed.

- *Services in temporary shelters*: Few issues with regards to limited space in tents, maintenance of water and sanitation facilities, garbage disposal and hygiene have been raised. Alternate arrangement for makeshift schools and distribution of stationary for the school children need to be given due importance. Similarly, provision of health facilities such as makeshift hospitals, deployment of doctors and paramedical staff, immunization facilities for children, healthcare for pregnant and lactating women and trauma counseling are required to be arranged promptly.

- *Compensation for damage and livelihood:* The compensation for damages and loss were lesser than anticipated. The compensation for livelihood should be given priority.

- *Alternate livelihood:* The affected people felt that livelihood helps the community to cope up with the situation in a better way and simultaneously provides economic support. After the earthquake not only primary workers but women and youngsters also look for some sort of engagement to keep themselves steady. Generally, it takes several months to restore the primary livelihood or go for alternative livelihood. Local government and NGOs should provide training to the villagers on masonry and crafts related skills.

- *Monitoring of new buildings for multi-hazard resistant construction*: All the new structures, particularly after the disaster had incorporated the multi-hazard construction technology. However, the new construction does not

comply with it. This raises serious concern towards lack of monitoring and implementation of building regulations and guidelines.

- *Renewal of housing Insurance schemes:* All the houses reconstructed were insured for a period of 10 years. The insurance was provided against 14 types of risks including fire, earthquake, cyclone and floods. All the fully damaged houses were compulsorily insured and others were optional. However, the households were not motivated to renew their insurance policies.

- *Coordination amongst stakeholders:* The survey highlights that although NGOs and International organizations worked in close coordination with the local government, few issues related to direct interventions of the humanitarian organizations and optimal distribution of relief were observed.

6. Lessons Learned and Suggestions

There were gaps in planning and capacity to handle immediate measures, early recovery measures and long-term measures. Thus, there is a need to build capacities of government, stakeholders and community in the area of recovery planning. Adequate pre and post disaster planning are required to ensure that the measures such as search and rescue, provision of medical facility and temporary shelter could be addressed at the earliest without loss of vital time. Similarly, restoration of basic services like water supply, sanitation, solid waste disposal, power supply and education facilities should be done at the earliest. The issues such as repair/reconstruction of houses/schools, trauma counseling and livelihoods should be given utmost priority. A dedicated fund for post disaster recovery may be kept to provide uninterrupted flow of funds. Focus on awareness about catastrophic risk products and importance of insurance should be given. Incorporation of hazard resistant features in newly constructed houses will further reduce the future risk. Hence, a robust monitoring mechanism should be developed by the government to introduce appropriate regulations and compliance mechanisms.

Community participation in all the stages of recovery planning and rebuilding was the key to success of Gujarat Earthquake Reconstruction and Recovery program. It is essential to involve the people in selection of relocation sites and their basic requirements. The partnership and trust between government and NGOs should be strengthened by developing guidelines for engaging them during different phases of recovery since the NGOs have better reach to the communities. They could be involved in the activities related to awareness generation, capacity building, housing reconstruction, humanitarian response, skill development and livelihood restoration.

7. Conclusion

There is a requirement for preparation of a Recovery Management Framework which could be done before hand and executed at the need of hour. Post disaster recovery comprises of a set of actions which not only helps to bring back community in the pre-existing conditions but also aims to make their life better. There are distinct stages for early recovery (3-18 months), medium term recovery (up to 5 years concurrent with early recovery) and long term recovery (5-10 years) based on which recovery policies and programs could be planned and implemented to achieve stage-specific objectives. Recovery framework with a set of objectives, institutional set up, financial mechanism, community participation and communication could be an effective management intervention for sustainable recovery.

In India although there is a policy consensus to "build back better" during recovery, on ground there are several challenges which are still unattended. The case study highlights common gaps which need to be addressed systematically to ensure better recovery of the community after a disaster. The sample survey was further extended to the State of Assam (Dhemaji district) for floods and Odisha (Ganjam district) for cyclone and it had been concluded that there was an urgent need to build the capacity of local governments (panchayat, block and district) on early recovery planning so as to ensure restoration of basic, social and economic services; to create a dedicated/earmarked fund for recovery and reconstruction planning; to promote risk insurance and social protection schemes; to strengthen partnership with NGOs and establish clear guidelines for engaging them during different phases of recovery; and to strengthen community participation and promoting community led recovery planning.

Acknowledgement

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References

1. H. Gupta, et al., *Bhuj earthquake of 26 January, 200,* J. Geological Society of India 57.3 (2001): 275-278.
2. USGS Earthquake Hazards Program , Earthquake Information for 2001, Archived for 2001, Retrieved in 2015 from www.earthquake.usgs.gov/earthquakes/eqarchives/year/2001/
3. The World Bank, Gujarat Earthquake Recovery Program- A Joint Report by World Bank and Asian Development Bank to the Government of Gujarat and India on

March, 2001; Retrieved in 2015 from www.preventionweb.net/files/2608_fullreport.pdf.

4. P.K. Mishra, *The Kutch Earthquake 2001 Recollections, Lessons and Insights*, (NIDM, Government of India, New Delhi, 2001).
5. A.K. Sinha, *The Gujarat Earthquake*, 2011, Retrieved from www.adrc.asia/publications/recovery_reports/pdf/Gujarat.pdf
6. UNDP, *From Relief to Recovery: The Gujarat Experience*, UNDP (2001). Retrieved from http://www.recoveryplatform.org/assets/publication/Gujarat%20Earthquake%20Recovery/gujarat%20recovery.pdf (2015).
7. UNDP, Field Study conducted in Assam, Gujarat and Odisha on Disaster Recovery (unpublished, 2015).
8. S. Agarwal, S and T.Verma, *Towards a Disaster Resilient Community in India*, J. South Asian Disaster Studies, Vol. 5, Number 1&2, (2012).
9. S. Agarwal, S and T.Verma, *Transition from Relief to Recovery - Role of Community*, J. South Asian Disaster Studies, Volume 5, Number 1&2, (2012), Vol. 2, Number 1, (2014).
10. S. Agarwal, T. Fulzele and G. Aggarwal, *Flood Recovery Management in Jammu and Kashmir: A Tool for Resilience*, J. Asian Journal of Environment and Disaster Management, Vol. 6, No. 3 (2014), p 215-229.
11. B.Hidayat and C. Egbu, *A Literature Review of the Role of Project Management in Post-Disaster Reconstruction*, School of Built Environment, University of Salford, Salford, Greater Manchester, UK
12. D. Alexander. *Principles of Emergency Planning and Management*, (Terra Publishing, Hertfordshire, England, 2002).
13. R. Chaskin, P. Brown, Chenoweth and Stehlik, *Community Resilience as an Indicator of Social Sustainability*, J. Society & Natural Resources, Volume 23, Issue 5 (2010).
14. Government of India, *Disaster Management in India*, Ministry of Home Affairs, (United Nations Development Programme, New Delhi, 2011).
15. Government of India, Disaster Management Act, The Gazette of India Extraordinary Part -II, No. 64", (Legislative Department, Ministry of Law and Justice, New Delhi 2005).
16. Government of India, National Disaster Management Policy, Disaster Management Department, Ministry of Home Affairs, New Delhi (2008).
17. Government of India, Draft India Disaster Recovery Framework, Ministry of Home Affairs, New Delhi (Unpublished, 2014).
18. ADPC, *Post Disaster Needs Assessments: Current Practices and future Recommendations*, (Asian Disaster Preparedness Center, New Delhi, 2015).

19. UNDP-BCPR (2011), Methodological Guide for Post-disaster Recovery Planning Processes Guidelines and Actions for National, Regional and Local Governments, Bureau for Crisis Prevention and Recovery - UNDP, Ecuador.

20. FEMA, National Disaster Recovery Framework, viewed on 31 Oct 2015 (https://www.fema.gov/national-disaster-recovery-framework), 2011.

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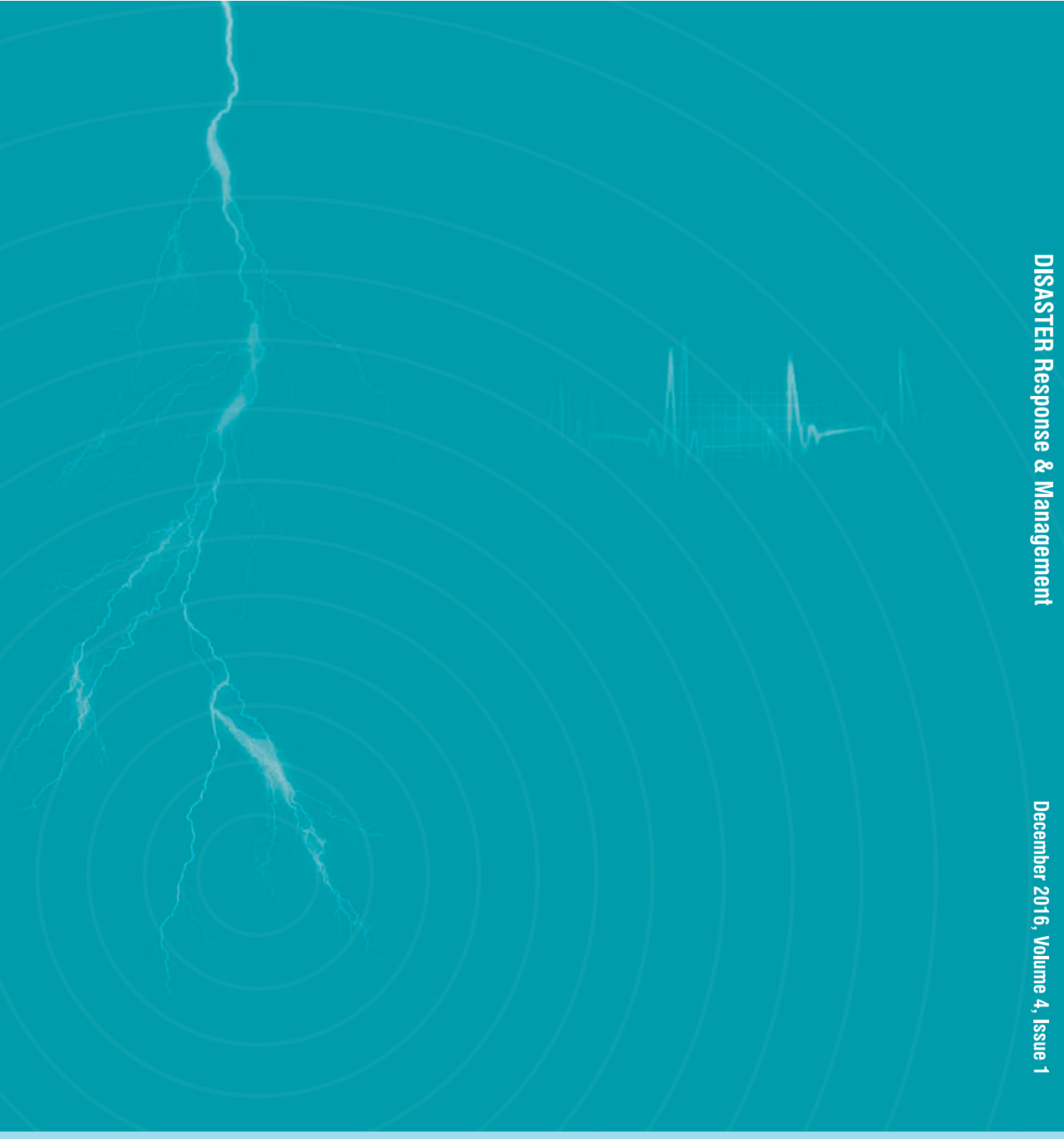

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