REVISITING THE 2013 FLASH FLOODS IN UTTARAKHAND – CRITICAL LESSONS LEARNT IN DISASTER MANAGEMENT

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ABSTRACT

Unprecedented rainfall due to a cloud burst led to a devastating disaster in the hill region of Uttarakhand in June 2013 in which thousands of lives were lost with immeasurable damage to property and environment. The hilly terrain and lack of disaster response plan led to further chaos as governmental and non-governmental bodies struggled to carry out search and rescue. Thousands remained stranded and died of hunger and injuries as they waited for rescue to arrive. The aftermath of the incident was blame from one side to the other but little concrete steps have been taken since to improve the disaster management in the State. Although a flood of this scale is rare, it is believed that with climate change a tragedy of this magnitude will happen again in the near future unless we acknowledge that the underlying risks are not unlikely events but rather the probable events which led to the Kedarnath tragedy. Through a committed and organized effort, disaster management can be improved and such tragedies averted.

Key Words: *Disaster management, disaster response, disaster preparedness, floods, landslides.*

INTRODUCTION

A devastating disaster struck the Indian state of Uttarakhand on 16-17 June 2013, when a cloud burst resulted in unprecedented rainfall causing melting of Chorabari Glacier and bursting of adjoining *Gandhi Sarovar* at a height of 3800 meters. Consequent overflow of river Mandakini led to heavy floods in Kedar valley in Rudraprayag district. Heavy to very heavy rains continued in the area causing floods and landslides. A number of villages and settlements were badly affected. Township of Ram Bada, a transition point to Kedarnath, was completely obliterated, while Gaurikund and the market town of Sonprayag suffered severe damage and loss of lives. Towns like Kalimath, Ukhimath, Agustyamuni and Tilwara down the stream suffered heavy losses of lives and property (Dobhal *et al*., 2013; DMMC, 2013; Kala, 2014).

As a result of the above mentioned disaster, more than 6,000 people were reported missing (believed to be dead) and more than a hundred thousand were stranded for days. In addition, the disaster caused widespread losses of public utilities such as bridges, roads, schools and other government buildings, and drinking water schemes (World Bank, 2013). The disaster also left stranded over 70,000 tourists and 0.1 million local inhabitants in the upper reaches of mountain terrain of Uttarakhand. The biggest ever rescue operation in the history of disaster management has been undertaken by Government of Uttarakhand with the

support of Army, Indian Air Force, Indian Tibet Border Police Force, National Disaster Response Force and Border Security Force. They evacuated more than 0.11 million people from the flood affected areas and also saved the lives of thousands of animals (World Bank, 2014). A large number of local people lost their livelihood because of various types of damages. Media reports suggest that such a massive loss of life could have been greatly reduced if an early warning system, effective evacuation plans and a responsive disaster management system were in place. In fact, the Comptroller and Auditor General had pointed out in April 2013, just a couple of months before the tragedy, that the Uttarakhand State Disaster Management Authority (USDMA), formed in October 2007, had never met or formulated rules, regulations, polices or guidelines.

Modestly priced radar-based technology to forecast cloudbursts would have saved lives. But, the weather radars were not installed and the emergency evacuation plans were also not drawn up. Some reports state that there was local-level governance failure, too. Haphazard and unregulated construction of roads and bridges was allowed on crumbling, landslide-prone ridges and steep slopes, ignoring the region's fragile geology and high earthquake vulnerability. Forests were destroyed on a large scale. Hundreds of buildings were constructed in the flood plains of rivers disturbing the natural terrain, which should be prohibited area for such activities (Kumar, 2013; Awasthi *et al.*, 2014; Nirupama, 2015; Sundriyal *et al.*, 2016; Ranade, 2016). Riverbeds were recklessly mined for sand. As construction debris accumulated, land contours and flows of streams and rivers changed. Indiscriminate building of hydroelectric dams was the worst culprit. This involved drilling huge tunnels in the hills by blasting rocks, placing enormous turbines in the tunnels, destroying soil-binding vegetation to build water channels and other infrastructure, laying transmission lines and carelessly dumping excavated muck. Many dams were built on the same river so close to one another that they left no scope for its regeneration.

Even the relief and rescue work after the catastrophe came under severe attack from many quarters. Relatives and friends of those missing were running around not knowing whom to approach for any credible information. In such a vast terrain, the relief agencies were unable to locate the stranded people in need of urgent rescue. The badly hit Rudraprayag district did not apparently have a District Magistrate for three days during the crisis. There were no efforts to stop the pilgrims from going beyond Rishikesh, a city in the foothills and a vital abort point for upward bound traffic, immediately after the tragedy had struck. Communications had broken down in many of these areas. The Home Minister of India has gone on record to declare that lack of coordination among relief agencies was hampering rescue work in Uttarakhand. Such things were bound to happen in a haphazardly launched operation without proper plan and a designated coordinating body (Naithani, 2016).

While media did its part by reporting the situation and the eyewitness account of the shortcomings of the Government and the administration to the public domain, it is left to the research community and competent bodies to thoroughly investigate and identify the causes that led to such gross mismanagement after a natural disaster, making a bad situation worse with immeasurable loss of life, property and irreparable damage to the environment.

Based on these studies, lessons should be drawn and recommendations made to deal with such disasters in future. Many researchers and organisations have attempted in depth study of Kedarnath Tragedy on the above lines. This paper aims to review the important lessons learnt in the aftermath of the deluge of 2013, through analysis of these studies and data obtained from the government database, with a view to suggest a comprehensive way ahead to ascertain the same mistakes are never repeated.

METHODOLOGY

Secondary data was extracted from Reports/Interviews, Published Documents, News items, Research publications, Inputs/Communications from Govt. Departments, NGOs/ Community Groups, Survey inputs, Academic/Research Institutes, etc.

Data source**:** EM-DAT: The OFDA/CRED International Disaster Database; Disaster data and statistics maintained by National Institute of Disaster Management (NIDM), Government of India and Disaster Mitigation and Management Center, Government of Uttarakhand (DMMC).

The paper aims to make a scientific, step by step, approach to Disaster Relief and Management as it discusses the key elements which influenced the catastrophic events of June 2013 separately in the subtopics. Each section, evaluates the underlying factors – the what, why and how based on the research studies and data available, the lessons learnt which is followed by the recommendations to mitigate such risks in the future, as part of the State Department's Disaster Management Plan.

DISASTER RELIEF & MANAGEMENT

Disasters often result in immeasurable loss of life and property with irreparable damage to the environment which can adversely impact the region for decades. The chief aim of disaster mitigation is to reduce or mitigate potential losses, along with the immediate and appropriate support and assistance to the victims so that they can recover effectively and rapidly. As Twigg (2015) points out, 'the whole process of disaster management, relief, rehabilitation, and recovery initiatives should contribute to long-term development and reduce vulnerability'.

While Disaster Management (DM) requires a robust multi-layer organizational structure for the overall management at national, state, districts and village levels (Tayal *et al.*, 2015), the results of research and committee reports indicate that there was no coordination among the governmental and non-governmental organizations. The first two days of relief and rescue are considered crucial after a natural calamity before it becomes a disaster. However, the lack of concerted efforts among the organizations not only resulted in a higher death toll but the relief resources were either mishandled, pilfered or improperly distributed among the people. This underlines why risk reduction initiatives need to be multidisciplinary in nature with partnerships involving a range of stakeholders. Sati and Gahalaut (2013) emphasize that this partnership must involve local communities who should be regularly trained in the relief operations and preparation of local facilities for immediate relief and rehabilitation. This will have a long term benefit for the society as it would not only improve the general awareness of risk mitigation among the locals but enable them to have continued vigilance, preparedness and conscious effort to reduce such occurrences. Kumari *et al.* (2016) add that reduction of disaster is equivalent to increased development and therefore cooperation and involvement of a large number of citizens, local disaster group and Non-Governmental Organizations (NGOs) is an important step towards disaster management and mitigation.

Often immediately after a disaster strikes, there is a hectic relief and rescue mission, mainly aimed at feeding the people and stalling the outbreak of an epidemic, but once this initial attention fades away the follow up action for the restoration of infrastructure, hospitals, schools, houses, and sources of livelihood of the affected people is either ignored or progresses very slowly (Tayal *et al.*, 2015). In this case study, the damaged region was very well defined and demarcated, but it is difficult to imagine the scenario if a major or great earthquake strikes the region where the damage could be far more widespread and even greater coordination and long term efforts for recovery will be required (Sati and Gahalaut, 2013).

This takes us to the key elements which led to such catastrophic results, discuss the lessons learnt and elaborate the recommendations that are

essential to make the future strategies more effective and must be incorporated in the Disaster Management Plan (DMP) for the Hill State:

1) Disaster Preparedness

Preparedness is defined by the United Nations International Strategy for Disaster Reduction (UNISDR, 2009) as knowledge, capabilities, and actions of governments, organizations, community groups, and individuals 'to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions'.

According to Naithani (2016), 'A potentially alarming situation, for which adequate warning was available, was ignored as a routine situation in Uttarakhand in June 2013 causing delay in taking required actions by the Disaster Management organization. National Disaster Response Force (NDRF) could have been deployed if the State Disaster Management organization was more proactive'. He further points that, 'The state and district level authorities still view Disaster Management as a relief centric activity and hence enough attention has not been paid to activities related to mitigation and preparedness. State Disaster Management Authority (SDMA) had no approved Disaster Management plan even after seven to eight years of enactment of the Act, completely disregarding the statutory requirement'.

Rautela, 2018 advocates, 'Although the SDMA was repeatedly highlighted for its failure to manage the situation but for effective disaster governance State Disaster Management Authority (SDMA), State Executive Committee (SEC), and District Disaster Management Authority (DDMA) are collectively responsible under the Disaster Management (DM) Act, 2005. There is need to strengthen and empower SEC. Disaster Preparedness is perhaps the first step to recognize the threat and then aim to deal with it when the situation arises. In order for this to come to fruition, a multi departmental effort in drawing up Standard Operating Procedures (SOPs) and protocols pertaining to command structure, reporting formats, procedures, and information exchange need to be laid down, circulated, and rehearsed well in advance to rule out possibility of lapses and confusion'.

The above highlights the grim reality of serious lack of preparedness by the State and its public even in the aftermath of such a tragedy. The existing system talks about Community Based Disaster Management (CBDM), but is not focused on identifying and implementing the required measures. This can only work when community at the local level is involved in the various stages of the response plan.

a) Public Awareness - Data collected from Uttarakhand reveals that any awareness about Disaster Management was restricted only at the academic institutions level, if at all, and general public was largely ignorant about it. Actions such as exhibition of film documentaries or mock drills thus are limited to schools and colleges and the community has no participation in such activities. Though the *youth groups* and *religious institutions* are active in the State, they have not been mobilized to spread awareness about Disaster Management (Naithani, 2016).

This strongly indicates the urgency to train personnel likely to face natural disaster as well as those who deal with the search and relief operations. According to NIDM (2015) there is need for exhaustive training on various aspects of disaster management and risk reduction for all the stakeholders, role players and it is essential that the State government reviews its training strategy and strengthens its training capacity. Tayal *et al.* (2015) suggest, 'the Pre-Service Training should be provided to volunteers to increase their ability to maintain their own safety and security during emergency and natural disaster situations and also help communities to develop preliminary preparedness plans, institute mitigation measures, and increase their capacity to cope with disaster situations'. The volunteers must be trained to stay on an alert and be available on short notice for fast deployment as these disasters are sudden and erratic (Kumari *et al.*, 2016).

b) Tourism - Tourism is one of the strongest drivers of trade and prosperity. According to the Ministry of Tourism, Uttarakhand, a total of Indian and foreign tourists arriving in the State in 2017 were *345.8 lakhs* (Indian) and *1.42 lakhs* (Foreign) in comparison to *105.4 lakhs* (Indian) and *0.54 lakhs* (Foreign) in the year 2001. This is a threefold increase and the economy of the State depends highly on its tourism sector due to its pilgrimages, however, the sector is largely unregulated, owing to which several illegal constructions have disturbed the State's fragile ecology (The Hindu, 2013; Bisht, 2017).

Rautela, 2018 recommends that the number of tourists/ pilgrims entering the hilly region which is prone to natural calamities needs to be controlled and the visitors registered. Besides keeping track of exact number of visitors, this would help in communicating with them in case of any emergency. This is particularly required in areas where people have to trek such as Kedarnath, Gomukh, Hemkund Sahib, Yamunotri, and Chota Kailash- Kailash-Mansarovar. In these areas, only a specified number of persons should be allowed beyond the check point at Gaurikund, Gangotri, Govindghat, Janki Chatti, and Tawaghat where only physical fit tourists and pilgrims should be allowed after a comprehensive brief on the terrain and weather conditions along with the other associated risks that the terrain might offer.

2) Development of Operational Procedures

Lack of connectivity and transportation, black marketing of essential commodities becomes a major challenge during disasters in hilly terrain and, therefore, there must be provision for stocking essential items like food grains, blankets, medicines at block and panchayat levels for emergency purpose. A storage network along with built in shelters for providing food to the stranded people needs to be established. In addition, there is a need to develop/revise and update/improve Disaster Management Plans (DMPs) at District/local levels, ensuring clear approach of vulnerability assessment; Risk mitigation plan with clear time-frame, roles and responsibilities; Development of Standard Operating Procedures (SOPs) for mitigation, preparedness and response in case of all major disasters.

3) Building a Robust and Sustainable Infrastructure

Building a solid infrastructure is essential especially in disaster prone areas such as the hill state of Uttarakhand but equally important is the safeguarding of the existing infrastructure and natural resources.

a) *River Bed Mining* - The State requires to systematically tackle this longstanding issue. This must not be influenced by the political might, wealth or muscle power of the contractors but essentially based on the scientific investigations where the ecological aspects are given due importance. It needs to have an area specific approach before giving lease and unsustainable mining of the riverbeds and illegal mining must be prohibited with a heavy hand.

b) *Hydroelectric Projects* - The damming of rivers has posed a huge threat to the State. The disaster has highlighted how the operating and under construction Hydropower Projects potentially increase the vulnerability of the already disaster-vulnerable region and yet the State has more than 244 projects installed and many more are proposed (Aggarwal, 2013). Himanshu Thakkar, coordinator of the South Asia Network on Dams, Rivers and People warned, 'That hydropower projects are not clean, green, cheap and renewable source of energy was known to any discerning observer. The disaster has only strengthened that case. It has shown how much more careful we need to be before taking up any more such projects. If we do not learn these lessons, the price is going to keep climbing. In assessing the role played by existing and under construction hydropower projects in the disaster, the Expert Body, formed in Oct 2013 and led by Ravi Chopra Committee, in its report submitted in April 2014**,** admitted that these projects had indeed increased the proportion of the disaster and that the region is fragile in nature due to unpredictable glacial and para-glacial activities'.

A large number of Hydroelectric Power Projects have been initiated in the region after the

State adopted the Public Private Partnership (PPP) policy but failed to clearly define the environmental impact or implement strict policies on the matter. As a result, the implementing agencies (mostly private companies) unabashedly violate any restrictions to serve their benefit thus increasing the magnitude of the flood fury in the region (Sati and Gahalaut, 2013). The NIDM (2015) proposes that the current energy policies of the State must be urgently reviewed and must include:

(i) A *muck disposal plan*, designating a proper site, well above the high flood levels, for muck disposal with procedures and checks for its transportation.

(ii) Other sources of *alternative energy* such as solar, wind and bio-energy need to be further explored in the Himalayan region.

c) Development Projects/ Illegal Construction - Road network is the blood line of transport of people and essential commodities to the remote regions of the Hill State. The road alignments in the hill areas made using old engineering techniques, indiscriminate hill cutting, river side construction and construction on seasonal stream has deeply aggravated the problem of landslides during heavy rains (Khanduri, 2018). As a result of these landslides roads get blocked, seriously challenging any rescue or relief effort, as it happened during the Uttarakhand incident which contributed to the higher number of casualties.

Widespread and heavy rainfall struck the State in June 2013 which resulted into heavy flooding and landslides in the region, especially the catchments of Alaknanda and Pinder rivers were severely damaged. As Khanduri (2018) points out, a total of 220 landslide incidences have been observed in the area in the aftermath of the disaster which have been mainly (nearly 80%) the consequence of either toe cutting for infrastructural development or toe/bank erosion by streams. Geomorphic and field observations also indicate the presence of a number of tectonic contacts that have rendered the area so prone to landslides.

Thus, strong emphasis should be laid on better roads in the mountainous region using modern, safe and green technology. Better alignment of the road network, keeping the same away from course of the streams should be studied and implemented in the road and highway policy of the State. In the meantime, alternate means of transportation such as helicopters and ropeways should also be strengthened.

Another reason for difficult rescue in the mountainous terrain is due to poor and unplanned construction work at the most vulnerable sites. In the last few decades, most of the living settlements, business and government structures have developed in low-lying areas, including the river floodplains consequently blocking the rain fed streams and rivulets. It is important to consider the geology of the terrain, slope stability, and geomorphology and drainage system before planning for any construction in the area (Sati and Gahalaut, 2013). It is, therefore, recommended that the urbanization policy ensures that construction in the region is highly regulated and mass awareness, relocation of habitations and infrastructure from high risk area is included as risk mitigation measures (Khanduri, 2018).

Therefore, a legal framework must be in place to prevent construction on unstable or steep slopes and encroachment in riverbeds must be strictly prohibited and all past encroachments must be immediately removed.

4) Efficient Use of Technology

With breath taking advancements in technology and wide access to internet and its applications, even in the remote hill regions, it is imperative that all means including the newer technologies such as artificial intelligence and robotics be used effectively to combat the threat of further disasters in the State. Not only will it help prevent loss of invaluable lives due to natural calamities but will be an economically prudent strategy for the State.

a) Telecommunication – The State's policy and the DMP must include the augmentation of wireless, satellite and ham radio communication system for

carrying out effective response and rescue operation in case of a calamity. Efficient means of emergency communication is vital in case the main system breakdown and therefore a provision of battery operated or solar mobile chargers should also be there in disaster prone areas.

Additionally for emergency alerts for the general public, some effective network like Short Messaging Service (SMS) Gateway system must be available. The DMP should outline how the alert and concise instructions should be delivered to all residents so they can move to safer areas before the calamity strikes the region.

b) Weather Forecasting - As per the India Meteorological Department (IMD) the rainfall in the state between June 15 and 18, 2013 was measured to be 385.1mm against the normal rainfall of 71.3 mm which was 440% higher, attributed to the confrontation of the SW monsoon front with westerlies. Warnings of heavy rainfall were provided by IMD but it appears that the communication of the forecasts and warnings was inappropriate (Ziegler, 2014).

Such phenomena can quite easily be monitored and plotted by a well-equipped weather monitoring station as sophisticated technology and satellite imagery is already available for this purpose. However, the forecasting and warning mechanisms failed in its objective as this vital danger warning never reached all those who were most likely to be affected by it. As a result no timely evacuations were carried out and several thousand people found themselves caught in the middle, facing the full brunt of nature. A review of the existing weather forecasting and information systems is therefore imperative. The accuracy of the disaster warnings, communication with local authorities, hydro-met data collection, and sharing capabilities should also be targeted for improvement. It is essential to establish advanced automated *Early Warning System* (EWS), especially for the inaccessible parts of the catchment areas on a permanent basis. In addition, it is recommended that there is a coordinated action and accountability of all EWS related public agencies under one umbrella organization in order to improve monitoring, warning, preparedness and response (NIDM, 2015).

Tayal *et al.* (2015) suggested, 'There is need for preparedness to remove all valuable assets from hazard-prone regions before monsoon, and mechanism to alert and evacuate locals at short notice through early warning systems. Manmade causes are eminently preventable by adopting suitable preventive measures using latest technology'. For this to work, the State, with the aid of the Central Government, needs to invest in monitoring weather, glacial lakes, and river flow for improving the accuracy of risk mapping.

c) Geology & Mapping of Hazardous Zones - The entire Himalaya in general, and Uttarakhand in particular, suffer from the natural phenomena of cloudburst, mass movement and seismicity. In order to combat or at least reduce their disastrous consequences we need to strengthen our technology and come up with new and innovative ideas for Disaster Management (Bisht *et al.,* 2017). Despite repeated flash flooding and landslide disasters in the past in several regions of Uttarakhand, there are still no proper micro-zonation maps for the landslide, floods and earthquake hazards available. NIDM (2015) recommends that the 'landslide risk micro-zonation should be based on ground truth of landscape, geology, ecology, vegetation, soil characteristics, human settlements, landslide and flood history of the site'.

Thus, there is an urgent need to prepare such maps and use modern *Geographical Information System* based tools for evaluating future risks in these vulnerable areas (Sati and Gahalaut, 2013).

Sundaramoorthy (2013), recommended creation of land use zoning regulations in the mountains based on landslide zonation maps and that all moraine-dammed lakes in the Himalayan catchments need to be mapped and their geotechnical stability assessed. Kumari *et al.* (2016) further reminds that as these natural phenomena are seasonal in nature an effective method to

combat them is to develop seasonal cycles of preparedness.

5) Governance

According to the data obtained from Centre for Research on the Epidemiology of Disasters (CRED), in the year 2013, India stood 5th in terms of reported disasters, 2nd in disaster mortality, 3rd in number of victims and 8th in damages caused (Guha-Sapir *et al.*, 2015) which underlines our extreme vulnerability to various natural disasters. The floods in Uttarakhand alone in the month of June, 2013, officially claimed 6054 lives while the actual numbers are suspected to be much higher.

Following a calamity such as this one, aids often arrive in the form of cash and essential commodities but appropriate management of such resources and channelizing those to those most in need is the essence of effective disaster response. The State simply cannot manage everything and requires concerted efforts from Central Government, State Government, NGOs, International agencies and private sectors. However, the State has to assume the overall control and draw an accountability policy in the interest of responsible disaster governance. Accountability, at its simplest, means holding public officials responsible for their actions (World Bank, 1992) and it is for the State Government to not only coordinate with all governmental and non-governmental organizations but to account for all activities and disclose the results of such actions in the most transparent manner (Sarkar, 2016).

6) Search, Rescue & Evacuation

All the policies, procedures, disaster management and contingency plans are eventually put to test in the real situation once the calamity has struck. The rescue and paramedical parties are then faced with the challenge of carrying out the tedious search and rescue operation in adverse conditions, in a difficult terrain and in the most time efficient manner in order to save as many lives as possible and transfer people to safety. Just having a disaster management plan written down on paper without thorough preparation, in-depth understanding of the challenges, sufficient trials and regular training will perhaps end in a deeper crisis.

The Uttarakhand disaster sadly unravelled some of these issues which need to be confronted and corrected. The following are some pertinent recommendations (NIDM, 2015) based on the lessons learnt from the incident:

i) The State's Disaster Management Plan must lay out a detailed *logistics setup* required in the entire region with special emphasis to the hilly areas. These plans must cater for reserve stock of rations, essential supplies and fuel at pre-determined critical locations. The State should take advice of the defence services, trained in specialized logistic strategies and of the geologists in order to identify ideal locations and develop all weather helipads. The NDRF also faced acute problem in moving their heavy equipment in difficult terrain, therefore, suitable and easily transportable or mountable equipment must be provided for the search and rescue operations in the hilly terrain.

ii) All disaster prone areas with high concentration of population, like Kedarnath, Badrinath and Chamoli, should have *alternate evacuation routes* which must be identified and maintained by the State.

iii) A more effective integration of the *voluntary agencies* and *non-governmental organizations*, at the district and local level, into the broader State level effort. The State Government should appoint a Nodal Officer in each district to maintain database of active NGOs in each district with their contact details and areas of intervention. Moreover, the Indian Disaster Resource Network (IDRN) database must be kept updated at all

times as an important information resource.

iv) The retired armed forces personnel may be encouraged to volunteer or contracted to provide their services and leadership in disaster response related activities.

v) Though the deployment of hundreds of ambulances during the Uttarakhand disaster proved very helpful in saving lives, yet their mobility and effectiveness was hampered due to frequent road blocks in the hill region and as a result several injured were taken on shoulders across the road blocks under very risky conditions. In coordination with other departments related to crisis management, the State Health Department should further strengthen its capability to provide public health and medical support during a disaster situation. The *medical relief plans* should therefore be integrated into the disaster response plans and resources earmarked accordingly. This should include fully equipped Response Teams with air ambulance support for immediate medical evacuation in tough terrain.

CONCLUSIONS

The tragedy that struck the Hill State in June of 2013 was not the first and will most certainly not be the last. Thousands of lives lost, livelihoods snatched and dreams shattered must mean something and stir us into action, drive us to make a resolve to never let it happen again. The cloud burst and heavy rains were harsh natural phenomena but we turned it into a tragedy and failed at many levels. The study revealed that the origin of this disaster was set many years ago, in the plundering of the environment, unregulated urbanization, indiscriminate hill cutting, poorly engineered roads and buildings, ill-planned reservoirs and dams, extensive and often illegal mining and quarrying of natural resources. The biggest failure of all is that as the dust settled most of us, including the Government, simply returned to our comfort zone, leaving things to fate (Bhandari, 2013).

There are many lessons to be learnt after this disaster and most important of them is to acknowledge that a change is needed and a cultural shift towards preservation and safety is required. The Government has to show leadership, accountability and a firm action plan to boot it. The Disaster Management Plan will not yield result if it remains only on paper without adequate implementation with all stakeholders, including the public, actively participating and taking responsibility. It will require checks and balances at every step and will certainly be tested when the next disaster knocks on our door.

The large floods are relatively frequent in the Upper Ganga catchment and heavy rainfall causes hundreds of landslides on steep slopes above the river channel delivering enormous and unquantified load of coarse sediment into the stream thus greatly reducing the capacity of the river channels to transport high flows (National Remote Sensing Centre, 2013). The climate change and the consequent fragility of the ecosystem cannot be turned around overnight but through recommendations made in this paper and through a scientific, responsible and structured approach to our disaster response we can perhaps reduce the adverse impact in the years ahead.

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