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SPECIAL ISSUE ON DISASTER MANAGEMENT

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The IC Centre for Governance has been set up in with the objective of collective thinking and acting on important issues of governance. It believes that public governance is too serious a matter to be left entirely to the state and that the involvement of the Civil Society is not only desirable but also essential. The Centre seeks to strengthen the capacity of Civil Society and government for ensuring good governance.

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EDITORIAL

The story (probably apocryphal) goes that the then Prime Minister of England, Benjamin Disraeli, was once asked the difference between the words misfortune and calamity. Disraeli is said to have replied that, if his political rival William Gladstone were to drown in the river Thames, it would be a misfortune, and that, if he (Gladstone) were to be pulled out, it would be a calamity!

Soon after the National Disaster Management Authority (NDMA) came into being, the Members settled the issue of nomenclature, and decided to follow the description used in the Disaster Management (DM) Act, 2005, namely disasters. While mankind has been exposed to the fury of natural and man-made disasters from times immemorial, there has been in recent times a particularly disturbing trend in their occurrence. A clear secular trend is visible in the intensity and frequency of disasters all over the world.

Also, experience has shown that, while the incidence of disasters is more or less uniform across the countries of the world, the impact thereof is unevenly spread, with the developed countries showing greater ability to overcome the after effects, as compared to the underdeveloped nations. And, remembering that the people of the developing nations are among the poorest in the world, one can understand why the subject of DM has been accorded great importance in the United Nations and other international and regional fora.

Over the last four decades or so, there has been a paradigm shift in the approach DM all over the world, away from the erstwhile post–event emphasis, towards a new focus on mitigation, preparedness and, in some cases, even prevention. In other words, the order in which the 2 Ps (Prevention and Preparedness) and 3 Rs (Rescue, Relief and Rehabilitation) of the DM continuum are dealt with, has been altered, with greater importance being attached to the 2 Ps and special attention on the M (Mitigation). Also, DM is being increasingly informed by the realisation that the use of state–of–the-art knowledge and sensitivity to the imperatives of environmentalfriendliness should be built into the design of the projects, programs and interventions.

What with the advent of hitherto unfamiliar challenges, such as climate change, natural resources degradation and pandemics, the time has arrived when doing things 'more' than earlier, or even doing them 'better' than before has to yield place to an era in which doing things 'differently' – is the need of the hour.

Use of Technology

For instance, traditionally, in the Post-Disaster Needs Assessment (PDNA), the visiting teams of Assessors have been shown what is 'considered' to be the damage. Many a time, for want of time to access far flung areas by normal modes of transport, the visiting teams are constrained to wear the lenses given to them by the local hosts. Also, when the visiting team does not go to certain sites, they are constrained to accept the 'second hand' information provided by local government in that affected area. Often, this results in an incomplete assessment of the total situation. This shortcoming should be circumvented by the use of Technology, namely with the use of Drone Technology and Satellite Imagery. It is time to resort to such objective strategies that are not only authentic, but also give a total picture of the disaster.

For millennia, mankind has asked and interrogated the external environment and Nature has provided answers to the questions posed. In the complex and rapidly changing scenario that is unfolding today, the crying need is to find the right questions to ask!

If Abraham Lincoln's concept of democracy was one of putting in place a government "of the people, by the people and for the people," I have taken the liberty of introducing the word 'with' to suggest that no democratic form of governance is complete without the requirement of inclusion being met. Unless people are involved and participate in the process, there can neither be inclusive policy making, nor ownership of the outcomes of public interventions. Therefore, strong community participation has been a significant element of the approach of the central/state governments and the other stakeholders in the process of DM.

This Special Issue

The DM scene in the country is fast changing, and a lot needs to be done still... This Special Issue of the Journal of Governance provides a panoramic view through three windows to the past, present and expectant future of Disaster Management in India. In 27 papers, the subject is elaborated to address 5 facets, namely:

(A) Introduction to Disaster Management in India,

(B) Macro-View of Disaster Management,

(C) Disaster-Specific Tracks in Disaster Management,

(D) Cross-Cutting Themes in Disaster Management, and

(E) The Road Ahead for Disaster Management,

It is hoped that the readers will find valuable pointers in the papers authored by those who have had a close look at DM as practiced in India so far.

Mohan Kanda

A. INTRODUCTION TO DISASTER MANAGEMENT IN INDIA

Mohan Kanda

The Changing Landscape of Disaster Management

Abstract: India has made a clear beginning towards effective Disaster Management (DM). Enactment of the DM Act (2005), articulation of the National Policy on DM and putting in place plans at the National, State and District Levels, release of Guidelines (thematic and cross – cutting), at the National, State and District Levels, and raising of the National Disaster Response Force (NDRF) constitute major milestones in the journey towards safety. This paper presents the broad rubrics of implementation of DM in India. It suggests a two-pronged approach, in the short-term, with available resources, by piloting a Model District Program capable of subsequent up-scaling, and the prudent use of technology, and in the long term, with additional resources, by a massive Human Resource Development exercise and taking, head on, the residual DM agenda.

Key words: Technology, Implementation, Residual Agenda, Documentation, Model District Program

1. BACKGROUND

Disasters are a major challenge that humanity faces. Recognizing this, a *holistic*, *coordinated* and *technology-driven approach* towards DM has been adopted for over half a century now, all over the world, especially in India.

1.1 Natural Disasters

There has been a steady rise in the number of global natural disasters reported from 1970 to about 2006 and a gentle drop thereafter. But, since the beginning of the new millennium, the number of reported natural disasters is still around 300 every year, indicating the continued high exposure of populations to disasters. In India, earthquakes disasters alone have caused major loss of life. For example, the 2001 Gujarat Earthquake killed about 13,800 persons, the 2004 Indian Ocean Tsunami more than 17,000 persons; and, the 1993 Killari earthquake about 8,000 persons. In the state of Andhra Pradesh, two tragedies, namely the 2009 Floods (Krishna), and 2010 Cyclonic storm (Laila), together resulted in an estimated loss of about Rs. 13,630 Crore. That was about 5.14% of the state's GDP and greater than the state's growth rate of about 5.04%. Clearly, these economic losses are beyond the capacity of the state to absorb without causing severe setbacks to ongoing and future socio-economic development and growth. A regrettably secular increasing trend in the intensity and frequency of disasters, whether natural or manmade, is in evidence all over the world. A World Bank study has shown that nations lose 2 to 12% of their GDPs on account of recurring natural disasters. Also, experience has shown that while the incidence of disasters is more or less uniform across the countries of the world, the impact thereof is unevenly spread, with the developed countries showing greater ability to overcome the after effects, as compared to the underdeveloped nations. And, remembering that the people of the developing nations are among the poorest in the world, one can understand why the subject of DM has been accorded great importance in the United Nations and other regional fora.

1.2 The Early Days of NDMA

In India, while traditionally strong and robust rescue and relief mechanisms have been in focus, aspects relating to the prevention, mitigation, and preparedness had taken a backseat for a long time. The 2004 Tsunami acted as a wake-up call and a year later, the DM Act, 2005, came into force. It was a well-conceived, self-contained, far-sighted enactment, which, at once, dealt with statutory, administrative, financial, and operational aspects of the disaster continuum comprising the 2 Ps (namely, *Prevention* and *Preparedness*) and 2 Rs (namely, *Response*, including Rescue & Relief, and *Recovery*, including Rehabilitation & Reconstruction). Also, it brought in a paradigm shift in the focus, away from the hitherto post-event syndrome to a new emphasis on prevention, preparedness, and mitigation. The Act acted as the fountain for several important documents, such as the *National Policy on Disaster Management*, the *Guidelines* for handling various Natural and Manmade Hazards, and the *Guidelines* on thematic areas (*e.g.,* medical preparedness and incident response systems). Flowing out of the sequential arrangements of the act, the rules made there-under and the National Policy, departments of the central government and all the States/UTS have since prepared DM plans to spell out both *structural* and *non-structural* measures for the management of disasters specific to their remits and spatial jurisdictions. Also, every district in the country has a DM Plan.

As part of the effort to mainstream DM concerns into the developmental effort, the central government made a beginning by amending the *Check Memo* for sanction of projects to introduce a requirement that region-wise and disaster-wise features need to inform the design, structure, and choice of materials in various projects, such as irrigation dams, power plants, roads, bridges, and rail tracks. In keeping with the worldwide trend of ensuring that all developmental activity is sensitive to the imperatives of environmental safety, suitable mechanisms were put in place in India to ensure that DM related interventions also are environmentally friendly.

1.2.1 The DM Framework

Until 2001, DM was the responsibility of the *Ministry of Agriculture*. With the increasing frequency and severity of disasters, many committees were constituted by the Government of India on DM, prominent among them being:

(1) The *High Powered Committee* under the Chairmanship of Shri J. C. Pant in August 1999, prior to the occurrence of the October-1999 Orissa Super Cyclone; and

(2) The *All-Party National Committee,* under the Chairmanship of the Prime Minister in February 2001 after the 2001 Gujarat Earthquake.

Consequently in June 2002, the responsibility of DM (except

Drought and Epidemics) was transferred to the *Ministry of Home Affairs (MHA).*

On 23 December 2005, the Government of India piloted the passage by Parliament of the *DM Act, 2005*, which envisaged the creation of the *National Disaster Management Authority (NDMA)*, headed by the Prime Minister, and the *State Disaster Management Authorities (SDMAs)* headed by respective Chief Ministers, to spearhead and implement a holistic and integrated approach to DM in India (NDMA, 2020).

The Vision of NDMA is: "To build a safer and disaster resilient India by a holistic, pro-active, technology driven, and sustainable development strategy that involves all stakeholders and fosters a culture of prevention, preparedness and mitigation." After in-depth consultations with the stakeholders concerned at the central and state levels, and several rounds of discussions, it was decided finally at the highest level what the allocation of roles should be as between NDMA and the central government, the nodal ministry is the *Ministry of Home Affairs (MHA).* Accordingly, all aspects of DM except immediate response remain the remit of NDMA. MHA handles immediate response together with the state governments, whose primary responsibility is DM. The difficulties that arose in the USA in settling the issues relating to the division of turf between the then newly created, Department of Homeland Security and the existing FEMA also served as pointers for that arrangement.

1.2.2 Work done by NDMA

The NDMA brought a *paradigm shift* in the approach of the nation to facing disasters by adopting a holistic and the integrated approach by placing *Mitigation* and *Preparedness* at the center stage, instead of being response-centric and just undertaking *Response* and *Recovery*.

The establishment of the *NDRF* as a disaster response agency under the NDMA was a significant step. The Force started with 10 battalions distributed in different parts of the country. They operate highly skilled rescue and relief operations, regular and intensive training and re-training and familiarization exercises within the area of responsibility of respective NDRF battalions, while carrying out mock drills and joint exercises with the various stakeholders. Easily one of the most significant achievements of NDMA in its early days was the raising, equipping, and training of the NDRF. The Force, in ensuing years, has given an excellent account of its ability to move in anticipation, the station itself in vulnerable areas, and deal effectively with the demands of rescue and relief. In response to a question of the then Prime Minister, the then members of the NDMA drew upon their varied and long experience in different fields of public administration and prepared a '*synthesis of gut feelings*' based estimate of the degree of preparedness of the country for disasters. That exercise is now in the process of being formalized and subjected to a rigorous refinement to prepare a formal *Disaster Preparedness Index* for the country, which hopefully will act as a model for the whole world when it is ready.

One of the outcomes of the vision of NDMA was mainstreaming the DM activities into the governance framework. NDMA issued guidelines for different disasters and different ministries. The state governments made finer plans. The measures included both *structural measures* (like embedding disaster resilience in infrastructure projects auditing them and taking corrective measures) and *non-structural measures* (like enabling regulatory measures, legal aspects, training of functionaries, and generating awareness). Fortunately, the 13th Finance Commission provided Rs. 525 Crore for up-gradation and capacity building of SDRFs, and Rs. 200 Core for strengthening fire services.

The NDMA undertook various capacity-building programs with 260 mock exercises conducted across 94 districts training over 16,50,000 community responders. Also, various sensitization programs were organized for the functionaries, i.e., 211 for IAS and other civil services officers, and 1,262 for IPS officers. Further, 40 programs were organized for corporate executives. Guidelines for addressing 4 disasters (namely cyclones, earthquakes, landslides, and avalanches) were prepared. Minimum standards were laid down for relief to be provided in relief camps with respect to food, sanitation, and hygiene and medical cover. In two years' time, the level of preparedness of the country towards natural disasters increased from 29% to 47% according to a rough-estimate arrived at by the Members of NDMA

1.2.3 Engaging with SDMAs: Responsibilities and Challenges

The primary function of SDMAs is to establish relationships with other departments that have to be synergetic, mutually reinforcing, productive, and harmonious. For doing so, they have the advantages of:

(1) Knowing the lessons learned by NDMA in formulating guidelines and formulation of DM plans;

(2) A compact and well-toned State administration; and

(3) Considerable interest from international and bilateral agencies

SDMAs started functioning in different States with 20 States having their State Disaster Management Plans (SDMP). SDMAs perform the whole gambit of responsibilities, including but not limited to laying down the policies for approving Disaster Management plans, coordinating the implementation, promoting general education and awareness, and facilitating knowledge sharing. Like any other authorities, the NDMA and SDMAs have to face different challenges in the self-formulation and self-implementation of their own activities. These challenges include minimizing losses to life and property, a need for informed leadership, integrating the plans with the developmental goals, and providing the funds required for the implementation of the plans.

Financial allocations to DM have been significant. About Rs.21,333 Crore was allocated to the *Calamity Relief Fund (CRF)* during 2005–2010 and about Rs.20,000 Crore was expended on *National Contingency Calamity Fund (NCCF) and Reconstruction* during the period 2005-09. The cumulative figure of over Rs. 41,000 Crore does not include the estimates of a loss of private property.

1.3 International and Regional Agencies

The United Nations (UN) created the United Nations Disaster Relief Office (UNDRO) in 1971 as a focal point of the UN System for matters relating to the study of prevention, control, and prediction of natural disasters and providing advice to member governments on pre-disaster planning, among other things. Also, the UN declared the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) recognizing the importance of reducing the impact of natural disasters. In and its Plan 1994, the First World Conference on Disaster Reduction was held at Yokohama in Japan and endorsed the Yokohama Strategy.

The *Economic and Social Council* of the UN launched the *International Strategy for Disaster Reduction (UNISDR)* in 1999. It was meant to be an institutional framework for responding to the challenge presented to the international community by increasing the incidence of and scale of disasters. Along with UNISDR, the Inter-Agency Task Force (IATF) on Disaster Reduction was also created. Those two agencies were given a complete set of objectives for transforming the integrated into mainstreaming risk reduction to developmental policies and processes at the World Summit on Sustainable Development, held at Johannesburg in 2002. The Second World Conference on Disaster Reduction took place in 2005 in Kobe, Japan, where "the Hyogo Framework for Action" was adopted. The 1st session of the Global Platform for *Disaster Risk Reduction* took place in Geneva in 2007.

1.4 Inconvenient Truths

Looking back is advantageous when casting the new avatar of DM to face future events in the country. But, this needs an objective mind and a humble heart to draw clear lessons from both the positive and negative experiences gained from the way DM was practiced in the past. Experiences help in demonstrating the contrasting strategies of implementation of the actions in the aftermath of disasters.

(a) The Chennai Floods

One would have expected more effective preventive actions in Chennai. Nearly all actions before and after the recent floods, unfortunately, presented a study in negligence. The floods were largely on account of shrunken drainage capacities, unplanned urbanization (that has drastically altered the shape and size of natural catchments) and encroachments in areas intended to be kept vacant for facilitating drainage, blockages of drainage systems, haphazard paving of roadsides, parks, open areas and indiscriminate disposal of solid wastes.

Neither the decision to release waters from the Chembarambakkam Reservoir nor the opening of the flood gates at Adyar River were actions based on purely technical grounds. Those decisions as well as the delay (an unforgivable lapse on the part of the authorities) in alerting the police and the revenue authorities to the consequences to be anticipated were taken on extraneous considerations. Thus, the public was caught by surprise and subjected to totally avoidable misery. The complete absence of coordination between the various agencies concerned, the regrettable lack of delegated authority as well as disrupted lines of command and chains of control caused untold misery to millions of citizens.

The *Flood Plane Zoning Regulation* circulated in 1975 in a draft form by the Government of India has remained on paper thus far. If only it had been put in place and followed, a substantial amount of loss of lives and property could have been averted in several recent events of floods and urban flooding. Critical infrastructure facilities would then not have been located in low lying areas, especially in large cities, and large scale disruption of air and road transport would not have taken place.

The story of handling of the opening of the gates of the spillways of the Red Hills Reservoir during high rains in Chennai stood as an example not to be emulated. The decision making was centralized at the level of the highest executive of the State of Tamil Nadu. The lack of sufficient technical competence and absence of the use of classical tools (like hydrologic analysis involving flood forecasting and flood protection, which is related to reservoir design and spillway design) led to undue delay in timely decision making related to the opening of the gates of the spillways of the reservoir.

(b) The Japan Earthquake and Tsunamis

On 13 March 2011, an earthquake happened in Japan followed by Tsunami and Fukushima radiological disaster. In what was seen by the international community as an unprecedented gesture, the Japanese government sought the assistance of its Indian counterpart in the rescue and relief activities undertaken in the wake of the massive earthquake followed by a Tsunami and a radiological disaster in Japan in 2011. A 46-member team, fully equipped, duly protected, self-sufficient, and capable of round the clock operations was dispatched in response to that request. The team managed to extricate many bodies from the rubble more than two weeks after the disaster even in the absence of heavy equipment. Also, they recovered and handled about ¥50 million cash and various valuables to authorities. The effort of the team was appreciated by local authorities, the public, and the media of Japan. The Government of Japan conveyed an appreciation to the *Embassy of India*.

It is a matter of great satisfaction and pride that the team acquitted itself admirably and won all-round praise including the Japanese government and the local community. Of significant note, in that situation, was extraordinary patience, fortitude, and restraint exhibited by the Japanese people. They remained calm, and observed discipline in standing in queues for the for their requirements, only bought what they needed for the moment so that everybody else could get something, and exhibited no haste while traveling on the roads in motor vehicles. Elderly people and children were shown special attention and care. In a rare gesture, restaurants cut prices and even the media abstained from sensationalism and exaggerating the dimension of the tragedy.

The communities at the prefecture-level took charge in the golden hour and showed how the tireless number and quality of rehearsals during the peacetime are effective in helping citizens internalize their role during the emergency. The anecdote of school children being moved to high ground immediately after the earthquake ground shaking demonstrated that the process has been internalized by the local communities. Participating in the relief work gave an opportunity for Indians to learn from the way things are done and handled in Japan. These include:

(1) *The Calm*: Not a single chest-beating or wild grief scene

(2) *The Dignity*: Disciplined queues for water and groceries

(3) *The Ability*: The incredible architects

(4) *The Grace*: People bought only what they needed for the present, so everybody could get something

(5) *The Order*: No looting in shops. No honking/overtaking on roads

(6) *The Sacrifice*: 50 workers stayed back to pump seawater in nuclear reactors

(7) *The Tenderness*: Restaurants cut prices. The strong cared for the weak.

(8) *The Training*: Elderly people & children, everyone knew exactly what to do. And they did just that.

(9) *The Media*: Showed magnificent restraint in bulletins. Only calm reportage

(10) *The Conscience*: When the power went off in a store, people put things back on the shelves & left quietly.

(c) The Uttarakhand Flood Disaster

The Uttarakhand disaster also offered several key lessons to be learned, which included, among others, the following:

(1) This unfortunate psyche is illustrated by the fact that only two out of 29 States have enacted the Flood Plain Zoning Regulation (circulated in a draft form by Govt. of India as early as in 1975!), the exhortations of NDMA notwithstanding.

(2) The NDMA has gone on record identifying haphazard human intervention as one of the key reasons for floods. Extensive deforestation and unbridled illegal construction have only exacerbated the situation. In the case of Uttarakhand, all these factors played a role. The alteration in the course of river Mandakini magnified the impact.

Defective mining policies of the State were also to blame.

(3) A policy facilitating the transfer of land parcels to the revenue department, previously belonging to the forestry department hugely contributed to the disaster.

(4) Despite 13 districts in Uttarakhand being in Seismic Zone IV (where earthquake ground shaking of *severe intensity* is expected) and V (where earthquake ground shaking of *very severe intensity* is expected), several dams and roads had been constructed in violation of regulations in place and along fault lines.

(d) The Phailin Super-Cyclone

The Phailin super cyclone hit coast of Odisha State on October 12, 2013. Meticulous and elaborate DM ensured that losses were kept to a minimum. Continuous monitoring played a significant role in the operation. The large scale evacuation of people to keep infrastructural and losses to the human life to the minimum could be directly attributed to the lessons learnt from the Orissa Super Cyclone of 1999. Owing to the deployment of disaster response teams, the pre-positioning of equipment and effective coordination between and amongst State, national and local agencies, restoration of connectivity was carried out briskly and promptly. As part of a multi-pronged strategy to coordinate the efforts of the aid agencies and the State government with the help of the army and the navy were satisfactorily utilised. The mock drills and exercises earlier conducted by NDMA had created a great deal of awareness amongst the communities in the region.

(e) The Hudhud Super Cyclone

Hudhud was one of the most devastating cyclones to hit India's eastern coastline in recent times. For the first time, a cyclone landed on a major urban agglomeration, i.e., Visakhapatnam. But, the number of human causalities was minimal thanks to the early warning which was issued significantly in advance, and the consequent extensive preparedness. With nearly a week's time in hand, it was possible to minimize loss of property and lives through many preventive measures. NDRF was pre-positioned at vulnerable locations within hours of the receipt of the warning.

2. THE DM CYCLE

DM involves organizing and managing resources and responsibilities for dealing with all humanitarian aspects of likely emergencies before and after their negative fallout [RC, 2020]. This effort is undertaken to lessen the impact of disasters in the five phases of the DM continuum, namely *Prevention*, *Mitigation*, *Preparedness*, *Response* and *Recovery* (**Figure 1**).

Natural disasters cannot be prevented from having a negative fallout, but those manmade can be, to a large extent (through intelligence, deception, physical & operational protection, and structural hardening). But, preventing manmade disasters through these dominantly active options is expensive. Also, the fury of natural hazards is many orders of magnitude higher than that of the manmade. Hence, the only passive options are considered to be affordable and to a large extent effective in addressing natural hazards.

2.1 Long term Need

The paradigm shift that India has ushered in through the DM Act, 2005, has placed greater emphasis pro-active effort *vis a vis* instead of reactive effort. This means that a large part of the attention should be paid to pre-event phases of the DM Cycle, especially *Mitigation* and *Preparedness*. These need to be pursued rigorously at a vigorous pace.

2.2 Current Compulsions

Unfortunately, the *vulnerability* of the existing built environment is high and the *preparedness* of communities is low to face these hazards. Therefore, it is a compulsion to bide through the catharsis of the post-event phases of the DM Cycle. Thus, India will need to continue to enhance the efficacy of post-event activities, namely *Response* and *Recovery*.

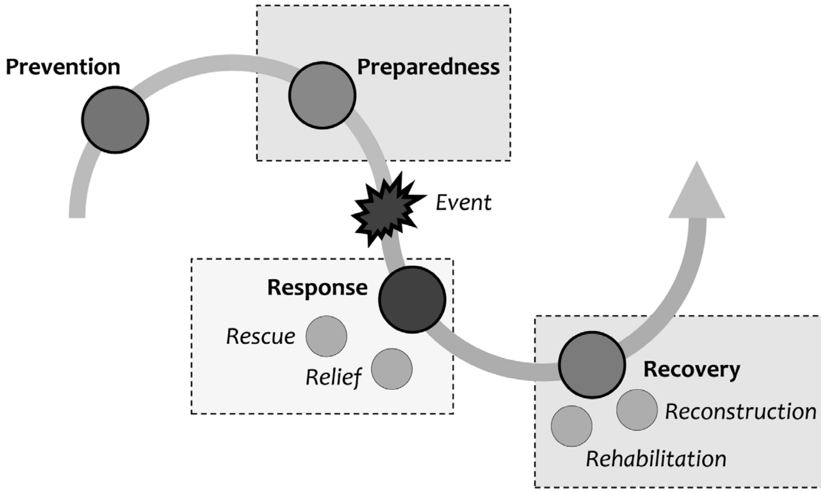

Figure 1: Five phases of the Disaster Management Cycle

3. SUSTAINABLE DEVELOPMENT

Sustainable development has many facets to it. Of these, two are prominent, namely:

(1) *Regulatory and Administrative Machinery:*

DM requires consistent involvement of all stakeholders which are placed on a gentle ramp of time – neither *too steep* nor *too shallow* to jeopardize the pace of development. This requires *systems and processes* to be established and practiced diligently. On the implementation side, of utmost importance is the discipline to follow these established systems and processes. Person-dependent performance is not acceptable in any office engaged in DM.

(2) *Physical Built Environment:*

The only gift from the stakeholders creating the built environment is "get it right the very first time." The pre-requisites for doing this "by the book" are:

(a) Strong Leadership (and, it's heartfelt willingness) at all levels,

(b) Competent Human Resources with state-of-the-art knowledge, modern skills, and positive attitude, and

(c) Uncompromised implementation at the site with due oversight of the techno-legal mechanisms.

Further, the traditional tenets of sustainable development of the physical built the environment are applicable even here, including: (i) adopting *re-cycle* and *re-use* policy, (ii) using *natural* materials as much as possible, instead of *engineered* materials, and (iii) employing *passive green* technologies in contrast to *active* technologies.

4. ENVIRONMENT SENSITIVITY

DM involves many activities, which affect the environment. These activities include the use of products that affect the environment and construction practices that disturb the environment.

4.1 Natural Environment

The golden rule of environmental sensitivity is to disturb the *natural environment* only minimally. Two golden rules for protecting the environment are:

(1) *Understand nature closely*, especially that which affects cascading losses: For example, keeping the natural waterways intact is essential. If waterways are encroached, the continued flow and the flash floods along these waterways are detrimental to the built environment hindering its natural flow.

(2) *Replenish nature consciously*, especially that which can be replenished: For example, if wooden houses are known to perform well in earthquakes, wood farming should be practiced to regularly plant equal if not more than the number of trees cut. Also, local native vegetation on the topsoil protects the erosion of soil. Thus, keeping such topsails intact is part of the environmental sensitivity.

4.2 Built Environment

Classically established good practices lack legal sanctity, yet. Even then, it is environmentally sensitive to adopt them without fail. For instance, even if the *Flood Plane Zoning Regulation* (circulated by the Government of India in 1975) does not have legal standing, it is only prudent to adopt them without fail, and thereby protecting the community from establishing human settlements below HFL. Similarly, not permitting habitat is in order along the coast at locations that are below HFL. This is in keeping with the law of the land, which has been in force through the definition of the *Coastal Regulation Zone* in the *Environmental Protection Act, 1986*, updated in 1991.

The natural environment poses contrasting challenges. For instance, the wind effect on a house requires the house to be massive and anchored to the ground, but earthquake effects require the house to be as light as possible. At a location where both wind and earthquakes are prevalent, it is necessary to enforce norms for ensuring **multi-disaster resistance** in the built environment.

5. IMPLEMENTATION

Considering the current disposition of the large demography of the nation, a *contemporary approach* to DM is imperative. Also, this approach should be two-pronged, namely:

(1) *Bottom-up* with strong community participation, and

(2) *Top-down* with strong policy and dynamically adaptive implementation.

Communities need to take ownership of the DM initiatives, while governments need to facilitate with proactive systems and processes and sufficient financial allocation.

5.1 Approach

The mainstreaming of DM by the states and Union Territories is taking the time. Understandably, many activities need to be undertaken towards achieving this. It would be prudent to classify these activities into three sets, namely *Vital*, *Essential,* and *Desirable Measures*. Ideally the limited (human, financial and time) resources available at hand, about 80% of energy should be spent on the *Vital Measures*, about 15% on *Essential Measures*, and the rest on the *Desirable Measures*.

The task at hand is determining how to place the needed activities in the said three boxes. Towards this end, the available options need to be prioritized, through a ABC Analysis. Here, the activities proposed by various stakeholders should be examined carefully and placed in three sets, namely:

(1) **Set A**: Those that must be done at all cost, and immediately;

(2) **Set B**: Those that need to be done, but at a later point of time. These activities need not be driven; they will get done;

(3) **Set C**: Those that should not be done at all, because they are bad practices, dangerous, not relevant, too expensive, out modeled, and those that need to be discontinued with immediate effect, if already underway.

The list of priorities should come out of such an analysis.

5.1.1 Do it differently!

With over 132 Crores of people waiting to be provided basic protection against disasters, especially natural disasters, the scale of implementation of measures of DM is large. It is not the time for doing incremental work, ticking boxes on paper, and making people live in a false sense of safety from impending negative fallouts of the prevalent hazards in India. For sure, to speed up and scale-up the implementation of DM, the fresh approach should be adopted that is **not just 'better', but also 'differently'**:

(1) It needs to be accurate, objective, and formal.

(2) It should leverage Information Technology and maximize decision making based on ground realities, rather than hearsay.

(3) It should have timelines for meeting targets, and mechanisms to incentivize successful implementation.

5.1.2 Use of Technology

Informed and dynamic decision making is the key in DM. Towards this end, DM should leverage modern technology; this will help overcome the current lack of competent manpower sufficient to address the needs of the nation and slow arrival of critical information. It will require generous use of modern technologies and state-of-the-art equipment and tools, in all initiatives –

especially in *Mitigation* and *Preparedness* initiatives. The value of the use of improved technologies is evident from the improved cyclone forecast in India in the recent times; finer accuracy in the arrival time and severity of the cyclone has helped in taking timely action to evacuate people from potential inundation areas.

Traditionally, in the *Post-Disaster Needs Assessment* (PDNA), the visiting teams of Assessors have been shown what is "considered" to be the damage. Many a time, for want of time to access far-flung areas by normal modes of transport, the visiting teams are constrained to wear the lenses given to them by the local hosts. Also, when the visiting team does not go to certain sites, they are constrained to accept "second hand" information provided by local government and other sources in the affected area. Often, this results in an incomplete assessment of the total situation. These shortcomings should be circumvented by the use of Technology, *e.g.,* with the use of Drone Technology and Satellite Imagery. It is time to resort to such objective strategies that are not only authentic, but also give a total picture of the disaster.

5.1.3 Model District Program

India needs to implement DM in 720 districts to protect over 132 Crores of people. The full picture is not clear to most decision-makers at the level of DDMA. Hence, a slightly different model should be considered. A district could be identified, having a small area (small population) and faced with at least three dominant disasters. For instance, a district in Himachal Pradesh could be identified, which is vulnerable to floods, landslides, and earthquakes. All the elements of DM, from *Policy* to *Plan*, to *Financial Allocation*, to *Implementation*, to *Review* can be completed end-to-end over a short period of 1-2 years in a *Mission Mode.*

This will require a number of strong steps to be taken, including:

(1) Putting in place all systems and processes needed in each vertical,

(2) Ensuring that the require techno-legal regime is available for effectively addressing Prevention, Preparedness, Response and

Recovery activities,

(3) Engaging the communities in a substantive way,

(4) Activating all EOCs and making the stakeholders use this for seasonal and annual festivals, celebrations, and activities, to learn the process of rehearsal, and

(5) Comprehensively documenting the entire process and showcasing to the remaining 719 Districts.

While few Districts may innovate and improve on the approach taken by the Model District, it is wishful thinking that most other Districts will follow it, at least to begin with and eventually improve on it to suit their requirements. Hence, an aggressive strategy is required to scale-up the success of the Model District Program over a reasonable timeframe in all other 719 districts, immediately after the Model District Program is completed.

5.2 Special Attention

If Abraham Lincoln's concept of democracy was one of putting in place a government "of the people, by the people and for the people," I have taken the liberty of introducing the word 'with' in place of "for" to suggest that no democratic form of governance is complete without the requirement of inclusion being met. Unless people are involved and participate in the process, there can neither be inclusive policymaking nor ownership of the outcomes of public interventions. Therefore, strong community participation has been a significant element of the approach of NDMA.

5.2.1 Increased Focus on SDMAs and DDMAs

The **DM Act (2005)** has been in force since 2005 and the *National Policy on Disaster Management* was released in 2009, the *National Disaster Management Plan* **released only** in 2016. But, it is heartening to note that as on date, all states have formed SDMAs and the *District State Disaster Management Authorities (DDMAs)*, with the exception of Telangana, which is yet to constitute the DDMAs. In fact, preparation of DM Plans is mandatory for all the States (SDMAs) and Districts (DDMAs), as adumbrated and required by

Sections 23 and 31 of the DM Act of 2005, and also by the National Disaster Management Plan (NDMP), released by the Prime Minister on 01 June 2016.

NDMP is the first-ever national plan prepared in the country. It aims to make India disaster resilient and significantly reduce the loss of lives and assets. The plan is based on the four priority themes of the "Sendai Framework," namely: understanding disaster risk; improving disaster risk governance; investing in disaster risk reduction (through structural and non-structural measures); and disaster preparedness, early warning and building back better in the aftermath of a disaster.

Also, all the states have prepared the SDMPs*;* and, of the 720 Districts in the country, 670 have prepared the *District Disaster Management Plans (DDMPs)*. Furthermore, rapid progress is understood to be made by the Central Ministries in the preparation of their corresponding *Disaster Management Plans (DMPs)*.

With all the DMPs almost in place, it is time to internalize the plans. More efforts are needed to bring onboard the SDMAs to increase the pace of implementing and mainstreaming DM in the development of the States. Hereafter, the focus should lie on creating the systems and procedures at work to support DM activities, peacetime rehearsals at the *Emergency Operation Centers (EOCs)* to streamline the chain of command.

5.2.2 Funds for Disaster Mitigation

In 2016, even though no separate grant was made available to each State for DM activities, the *Department of Expenditure* of the *Ministry of Finance* issued Guidelines in September 2016 allowing the use of funds from *Centrally Sponsored Schemes (CSS)* for DM activities. It permits each State to use up to 10% of their budgets under each CSS in a flexible way, for three objectives, namely:

(1) To provide flexibility to States to meet local needs and requirements, within the overall objective of any scheme, at the sub-head level;

(2) To pilot innovation to improve efficiency, within the overall

objective of any given scheme, at the sub-head level; and

(3) To undertake mitigation/restoration activities in case of natural calamities, or to satisfy local requirements in areas affected by internal security disturbances.

This amount of this flexible fund can be as much as 25% provided:

(a) The expenditure is in keeping with the overall aim and objectives of the already approved scheme; and

(b) States constitute *State Level Sanctioning Committees* with the participation of the *Central Ministry concerned.*

Even 10% of the budget is an opportunity for each State to begin DM activities, by:

(a) Putting in place systems and processes towards ensuring mitigation and preparedness activities;

(b) Training its personnel to internalize initiatives needed for DM in ongoing activities; and

(c) Developing long term mitigation and preparedness plans for DM.

But, based on a landmark recommendation of the 15th Finance Commission, the Government of India set up of mitigation funds at both national and state levels in the form of a *National Disaster Mitigation Fund (NDMF)* and *State Disaster Mitigation Funds* (*SDMFs*) [15FC, 2020]. This new methodology combines *capacity* (through past expenditure), *risk exposure* (through *Area* and *Population*) and *proneness to hazard* and *vulnerability* (through *Disaster Risk Index*). For the Financial Year 2020-21, the Rs.5,797 Crore for NDMF in the States' Corpus, especially for launching *Mitigation* activities (**Table 1**). This precious fund needs a judicious expenditure plan. It should be used primarily for the *Vital Measures*. Only in the extreme case, when funds are available in a year after meeting the *Vital Measures*, should the fund be used for the *Essential Measures*. But, in general, the grants available from the Centrally Sponsored Schemes should be considered for implementing the *Essential* and *Desirable Measures*.

Table 1: National and State Level Allocation for Disaster Risk Management for Financial Year 2020-21 (15FC, 2020)

Head	**Fund Allocated (Rs. Crore)**	
	National Corpus	**States' Corpus**
Mitigation (20%)	2,478	5,797
Response (80%)	9,912	23,186
TOTAL	**12,390**	**28,983**

Besides, most departments/ministries of the GoI and the departments of States and UTs should be made to set a priority to undertake DM activities before those that do not have DM implications. For instance, the *Ministry of Environment and Forests* can take up afforestation projects at such locations that will help mitigate disasters, say in such flood plains where the velocity of raging waters can be dampened, or in coastal areas where the speeds of the winds can be lowered with suitable tree shields. Similar compliance can be mandated in respect of important Ministries and Departments of the government of India and the states/UTS such as water resources, energy, surface transport, health, housing, Science and Technology, and Earth Sciences, (in respect of the government of India alone).

5.2.3 Post Event Documentation

Post-disaster Reconnaissance Surveys are valuable in documenting perishable lessons from each Disaster. Countries with advanced DM practices have been capitalizing on the inputs received from professionally experienced and competent teams of subject specialists that conducted such surveys. The lessons spread over issues of governance, community engagement, and the built environment. In this PDCA cycle, this exercise takes the center space of "CHECK" and becomes the input to ACT. India should embrace this process and strengthen the DM Policy, Plan, Guidelines, and Implementation.

The timing of the Survey Teams is crucial – too early can hinder the emergency activities underway and too late will mean losing the perishable lessons. In today's times, technology should be leveraged effectively. For example, the use of *Helicopters* and

UAVs for broad-brush surveys over a large area and of *Drones* for focused documentation of details in a local area has been adopted as effective strategies in many countries.

5.2.4 Addressing the Residual Agenda of each Hazard Holistically

Many measures that prevent disasters (especially from the standpoint of loss of life) usually lack *economic* or *political* appeal. Still, DM should embrace such an agenda boldly. For instance:

(a) Constructing cyclone refuge structures may not appeal either to those looking for returns or to those short-sighted seeking quick political mileage, but these do save lives;

(b) Undertaking peer review of structural safety of new structures proposed to be built may seem to be difficult a task for municipal offices, and therefore draw little political traction. Nevertheless, to save people's lives, this is a must-take elective;

(c) Constructing balancing reservoirs, which will help: (i) move the extra precipitation from certain catchments areas to these balancing reservoirs, (ii) reduce large discharge arising from the opening of the gates when High Flood Level (HF)L is reached in the said catchments, and thereby (iii) mitigate the flood disasters; and

(d) Prioritizing the maintenance of old existing structures *vis-à-vis* the construction of new structures. States have a fixed amount each year. In the anxiety to showcase development (motivated by prospective political mileage), new constructions have been winning the favor over maintaining and/or retrofitting the existing assets. For example, re-laying the concrete lining of canals, de-silting of tanks and dams, and earthquake retrofitting of buildings (especially those related to critical and lifeline services) go a long way in reducing future disasters, over-promoting new constructions with the available fixed annual grants.

5.2.5 Forecasting of Hazards

Significant progress has been made in so far as the accuracy of forecasting of *Cyclones*. But, the situation is not that bright in the other natural hazards. The forecasting of flood paths and their inundation areas and levels needs more hard work. Also, the accurate estimation of the earthquake ground shaking in the absence of a sufficient number of moderate earthquakes is found wanting equally. A determined effort is required to:

(1) Arrive at a nationally agreed methodology for accurately estimating and forecasting the different hazards;

(2) Revise temporally these estimates and forecasts of the hazards;

(3) Provide forecast at a granularity that is meaningful at the last mile. Also, the projected forecast should be combined with *value addition* with respect to a place for each hazard. For instance, the IMD's forecast of a likely good monsoon at the National and State level may not be of much value to a farmer. A forecast is not a forecast, if is not locally relevant. It has to be specific to a place to help the annual crop of that place. Excess water may be harmful to one crop, but a boon for another. Likewise, a monsoon in the catchment area of river Godavari in Maharashtra will affect the downstream states of Telangana and Andhra Pradesh. The timing and the higher volume of water at the downstream areas is more vital than stating the mere arrival of the same; such threats do not give opportunities to undertake DM on a scientific basis. These nuances should be understood and implemented with value addition by each agency engaged in forecasting; and,

(4) Project the prevalent risk from each hazard, and convolve them to get the composite risk.

Accomplishing these needs a mission mode approach for the nation to act swiftly towards implementing DM initiatives in a short time frame.

6. CLOSING THOUGHTS…

The unprecedented situation of the Corona Virus pandemic has posed a completely new challenge. We need to realize that nature is responsive to skillful interrogation. It is a question of finding the right questions not depending on outdated answers to no longer relevant questions.

That said, a realistic estimate of the mortality rate of any pandemic can only be accomplished, provided its spread has completely declined. The timeline is imprecise of the ongoing global pandemic COVID 19, referenced euphemistically as *The Great Reset*. The end of Corona Virus situation is not in sight; even the best of conjectures drawn from the Spanish Flu (1918-1920, which devastated the world, including India too over a hundred years ago) do not come anywhere near that of what happened in the other pandemics (like Swine Flu, Zika Virus, and SARS). Currently, a great chase is on for developing a vaccine to contain the Corona Virus, both globally and locally. This effort has brought nations and communities together.

The Corona Virus will continue to occupy center-stage of our activities in the near future, and we must cope with it through "online" *strategies* and *improvisations*. In time, pandemics should be seen as a major vertical in the list of disasters. The extra attention and effort to mitigate the effects of this virus notwithstanding, classical DM will continue to remain the major effort of all stakeholders involved...

References

1. RC, (2020), The Red Cross
   http://www.ifrc.org/en/what-we-do/disaster-management/about-disaster-management/
   Accessed on 30 August 2020
2. EMDAT, (2020), "Emergency Events Database," Centre for Research on the Epidemiology of Disasters
   https://ourworldindata.org/grapher/natural-disasters-by-type
   Accessed on 30 August 2020
3. NDMA, (2020), National Disaster Management Authority, Government of India
   https://ndma.gov.in/en/about-ndma/evolution-of-ndma.html
   Accessed on 30 August 2020
4. 15FC, (2020), Fifteenth Finance Commission, Government of India
   http://fincomindia.nic.in/ShowPDFContent.aspx
   Accessed on 02 September 2020

B. MACRO-VIEW OF DISASTER MANAGEMENT

Rikza Imtiyaz & Anil Kumar Sinha

History of Disasters and a Framework for Risk Reduction

Abstract: Every year, disasters impact human lives and take a significant economic toll. Governance plays a key role in reducing disaster risk and mitigating impact. The importance of proactive approach in disaster management is reflected in the Sendai Framework for Disaster Risk Reduction, which links research to key priorities, including understanding disaster causes, investing in resilience, and strengthening governance. India is a multi-hazard prone country with great diversity in its socio-economic profile which makes it highly vulnerable. However, with paradigm shift to disaster risk reduction and climate smart adaptation approaches rooted from global frameworks, not only India but the world is mainstreaming a proactive disaster management approach in its developmental policies. This paper gives an insight of evolution and development of various global frameworks on national and international level and their implementation world wide.

Key words: Risk reduction, Disaster Management, Vulnerability, Governance, Global frameworks, Sustainability

1. INTRODUCTION

Since 2000, several large-scale disasters have hit globally, especially the 2004 Sumatra Earthquake and Indian Ocean Tsunami, 2005 US Hurricane Katrina, 2005 Kashmir Earthquake, 2010 Haiti Earthquake, 2011 Japan Earthquake, 2015 Nepal Earthquake and ultimately the 2019 global pandemic Covid. While major disasters have happened before and smaller disasters occur almost every day, international concerns with disasters have increased significantly during the last two decades. Many international organizations, from the United Nations to the World Medical Association, are now involved in activities related to *prevention of*, *preparation for*, and *recovery from* disasters. Also, it has been recognized that there are many ethical issues in disaster management and response. "Vulnerability" of certain communities happens to be a direct cause of catastrophes leading to loss of life and economic slowdown. The most recent global disaster, *i.e.,* Covid 19 proved the importance of varying vulnerability on a higher scale. The functional definition underlines that vulnerability exists when all three components are present. For example, when there is a threat of an infectious disease, such as Covid 19, the exposure is in principle the same for everyone, but the sensitivity is different: children, elderly and economically weaker sections have more risks if they are affected. The adaptive capacity is better for persons who have access to medical care and medicines. Therefore, the most vulnerable groups are children and elderly with no, or only inadequate, access to the healthcare system. The exposure is in principle the same for everyone, as is the sensitivity. But the adaptive capacity is insufficient for homeless persons and low income groups as well. This is what makes them most vulnerable to virus and many other disasters.

Human activity increase exposure, increasing the propensity for systems reverberations, setting up feedback loops with cascading consequences that are difficult to foresee. Small changes can produce initial ripples, which can be amplified vulnerability and non-proactive approach, causing changes that lead to significant and potentially irreversible consequences. With increasing complexity and interaction of human, economic and political systems within ecological systems, risk becomes increasingly systemic. Thus risk reduction forms the very basic fundamental of good governance in tackling disasters.

2. EVOLUTION OF GLOBAL FRAMEWORKS FOR DISASTER RISK REDUCTION: A TIMELINE OF HISTORICAL EVENTS

Risk is complex. While it can be practical to categorize risk so that responsibility can be delegated to different organizations, institutions or individuals, risk management must not be "departmentalized". The *Sendai Framework for Disaster Risk Reduction 2015–2030* (Sendai Framework) emphasizes that risk is everyone's business – explicitly identifying the need for all-of-society and all-of-state institutions' engagement.

1970s

The potential consequences of natural hazards were becoming so severe, and were of such a scale, that much greater emphasis on pre-disaster planning and prevention was imperative, the *United Nations Disaster Relief Coordinator* convened a meeting of an *International Expert Group* in July 1979 to review six years' work of developing a methodology for risk and vulnerability analysis.

1980s

The work done in the 1970's laid the foundations for the development, planning and chain of actions 10 years later, of the International Framework of Action for the *International Decade for Natural Disaster Reduction* (IDNDR), beginning on 1 January 1990.

1990s

IDNDR intended to reduce loss of life, damage to property, and social and economic disruption caused by "natural disasters", especially in developing countries through concerted international action. The Secretariat was established at the United Nations Office in Geneva. Emphasis was laid on engaging and deploying existing scientific and technical knowledge to reduce the various losses caused due to disasters. IDNDR succeeded in raising public awareness (notably of governments) to move away from fatalism and to reduce disaster losses and impacts. A pivotal moment in IDNDR was the adoption (in 1994) of the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation, containing the Principles, the Strategy and the Plan of Action (Yokohama Strategy) at the World Conference on Natural Disaster Reduction.

1994

The Yokohama Strategy marked the beginning of a significant shift in the political and analytical context within which disaster reduction was being considered. While IDNDR was largely influenced by scientific and technical approaches, the Yokohama Strategy attributed great importance to socio-economic vulnerability in disaster risk analysis, emphasizing the crucial role of human actions in reducing the vulnerability of societies to natural hazards and disasters.

2000

Member States determined in 1999 that IDNDR would be succeeded by the International Strategy for Disaster Reduction (ISDR). The newly recognized ISDR had certain initiatives: (a) enable communities to become resilient to the effects of natural hazards, and related technological and environmental disasters, thus reducing the compound risk posed to social and economic vulnerabilities within modern societies, and (b) proceed from protection against hazards to the management of risk, by integrating risk prevention strategies into sustainable development activities. At the end of the period covered by the Yokohama Strategy, during 2004–2005, the United Nations Secretariat of the ISDR carried out a review of the Yokohama Strategy and Plan of Action for a Safer World. The Yokohama Review found evidence of greater official and public understanding of the effects of disasters on the economic, social and political fabric of societies, and stated that "significantly greater commitment in practice is required." Also, it identified challenges and gaps in five main areas, namely: (i) governance; (ii) risk identification, assessment, monitoring and early warning; (iii) knowledge management and education; (iv) reducing underlying risk factors; and (v) preparedness for effective response and recovery.

2005–2015

The Yokohama Review was submitted to the *Second World Conference* on Disaster Reduction (WCDR) in Kobe, Japan, in January 2005. It formed the basis for formulation of the Hyogo

Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters (HFA). The adoption and implementation of HFA following WCDR marked a milestone in catalysing national and local efforts to reduce disaster risk and in strengthening international cooperation through the development of regional strategies, plans and policies, and the creation of global and regional platforms for disaster risk reduction (DRR), as well as the adoption by the United Nations of the United Nations Plan of Action on Disaster Risk Reduction for Resilience.

Member States adopted a series of principles to support implementation of HFA including:

(a) The primary responsibility of States to prevent and reduce disaster risk together with empowered relevant national and local authorities, sectors and stakeholders;

(b) All-of-society, inclusive, engagement;

(c) Coordination within and across sectors and with relevant stakeholders at all scales;

(d) A multi-hazard approach and inclusive, evidence-based risk-informed decision-making;

(e) Addressing underlying risk factors through public and private investments informed by disaster risk;

(f) Strengthening international cooperation; and

(g) Emphasis on developing countries. Least progress was made in HFA Priority for Action (Reduce the underlying risk factors).

In general, institutional, legislative and policy frameworks did not sufficiently facilitate the integration of disaster risk considerations into public and private investment, environmental and natural resource management, social and economic development practices in all sectors, land-use planning and territorial development. Weak alignment and coherence in policies, financial instruments and institutions across sectors became a driver of risk.

Few countries adopted frameworks of accountability, responsibility and enforcement and also appropriate political, legal and financial incentives to actively pursue risk reduction and prevention. In addition, a few countries addressed the often inter-dependent risks they faced in a holistic manner, with investments in key sectors such as health, agriculture and food security, education, infrastructure, tourism and water omitting disaster risk. Incentive structures were found to be in need of reinforcing, including the encoding of costs and benefits of DRR in economic valuations, competitiveness strategies and investment decisions, including in debt ratings, risk analysis and growth forecasts or the inaccurate pricing of risk in the global financial architecture. Therefore, hazard exposure in both higher and lower income countries increased faster than vulnerability decreased, new risks were being generated faster than existing risks were being reduced. The value of lost and damaged housing, businesses, infrastructure, schools, health facilities and other assets increased relentlessly, leading to increases in contingent liability and sovereign risk for governments in many instances.

Underpinned by poorly planned and managed urban development, environmental degradation, poverty and inequality, and also weak risk governance, frequent and extensive low-severity disasters were found to increasingly affect the more vulnerable elements of society, thus challenging the achievement of social development goals. With the causes and consequences of risk being transmitted across geographic regions and income classes, between present and future generations and between social and economic sectors, HFA helped to identify disaster risk as a critical issue of global and regional governance, national safety and security, and a threat to the achievement of sustainable development.

2015: Sendai Framework for Disaster Risk Reduction

The Framework was adopted at the 3rd UN World Conference on Disaster Risk Reduction in Sendai, Japan, on 18 March 2015. The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks, namely: (i) Understanding disaster risk; (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster reduction for resilience and; (iv)

Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction. It aims to achieve a substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years. Soon after the Sendai Framework had been negotiated at the 3rd WCDR, Nepal was struck by the powerful Gorkha Earthquake on 25 April 2015. Ravaged by the initial event, numerous aftershocks and another quake 17 days later, Nepal suffered huge losses, namely: 8,891 people lost lives, 22,303 seriously injured and millions rendered homeless. Nepal had to absorb damage and tangible losses of an estimated US$7 billion, a bill it could ill afford. It was an alarming reminder of the devastation wrought when the context of hazard, exposure and vulnerability is allowed to evolve without adequate attention to the corollary risk it is building and ultimately causing tremendous losses.

The principles of Sendai Framework reflect the collective responsibility of all stakeholders, i.e., people, governments, communities, the private sector, investors, media and civil society to effectively reduce disaster risks. The Sendai Framework strictly follows risk-informed approach that increases the capability to protect populations and also ecosystems by managing the emerging possible risks. The 2030 Agenda for Sustainable Development (2030 Agenda), the outcome and goal of the Sendai Framework is underpinned by the principle of universality, recognizing that no society (regardless of income classification) is immune to the negative consequences of realized risk. Traditional event-based estimates of impact attribute most economic losses to high-income nations (a function of the higher monetary value of insured damaged assets), while the human cost of disasters is substantially higher in low- and lower middle-income countries. Such analyses correctly identify the most vulnerable segments of the world's population as consistently suffering the most harmful effects – in many instances, reversing development gains, corroding resilience, undermining sustainability, eroding wellbeing and diminishing socioeconomic growth. The Sendai Framework reflects that the nature of risk has changed to such a degree that it surpasses established risk management institutions and approaches.

Recent events (such as large-scale prolonged droughts and heat waves, financial and commodity market crashes, large scale and long term human migration, cyber vulnerabilities and political upheavals) carry the potential to generate diverse types of damage and destruction simultaneously, to vital infrastructure and even to the life support systems of very large parts of societies and economies. With nonlinear change in hazard intensity and frequency a reality, and now threatening all three dimensions of sustainable development, the imperative is clear for greater ambition and accelerated systemic action pre-2030 to converge with the Sendai Framework. The Sendai Framework compels new conceptual and analytical approaches to improve understanding and management of risk dynamics and risk drivers at a range of spatial and temporal scales. It requires particular emphasis on the interaction among physical, technological, social and environmental hazards, and attention to "anthropogenic metabolism."

The 2019 Global Assessment Report on Disaster Risk Reduction (GAR) is informed by the latest data (including Sendia Framework target reporting by countries using SFM) and infers early lessons on the state of the global disaster risk landscape. While the period of observation is still too short to reach definitive conclusions at a global scale, it is possible to ascertain certain patterns in terms of magnitude, geographic and socio-economic distribution of impacts and abstract several points of departure for where and how countries have seen successes in reducing risk. The data given below highlights the current status of targets of Sendai Framework globally:

Target A – Mortality relative to population size has declined in the long term. But, since 1990, 92% of mortality attributed to internationally reported disasters associated with natural hazards has occurred in low- and middle-income countries, persistently concentrated in the Asia–Pacific region and Africa. Geophysical hazard events have taken the highest toll on human lives. While most fatalities are a result of realized intensive risk, the proportion of mortality accounted for by realized extensive risk is rising. Occurrence of reported disasters associated with biological hazards has decreased over the past two decades, while the number of disasters associated with natural hazards has increased slightly.

Target B – Multi-hazard disasters affected 88 million people in countries reporting through SFM in the period 1997–2017, with floods affecting 76 million people. Disasters stemming from natural hazards have displaced an average of almost 24 million people each year over the last decade and remain the main trigger of displacement.

Target C – 68.5% of all economic losses in the period 2005–2017 were attributed to extensive risk events, as was the persistent erosion of development assets identified in previous GARs. Losses incurred as a result of the realization of extensive risk continue to be vastly underestimated and often absorbed by low income households and communities.

Target D – Economic losses incurred in the housing sector account for two-thirds of the total, with losses to agriculture the second most-affected sector. Data are imperfect, and disaster losses remain significantly underreported, compromising accurate calculations of impact.

Target E – Immediate and focused action is required to meet the 2020 deadline for national and local disaster risk reduction (DRR) strategies aligned with the Sendai Framework. Progress has been steady, but is insufficient given that such strategies are seen as the foundation for achievement of the 2030 targets.

Target F – Development assistance for DRR has been highly volatile, ex post and marginal. It is miniscule compared with financing for disaster response. A total of $5.2 billion for DRR represents 3.8% of the total humanitarian financing between 2005 and 2017 – less than $4 for every $100 spent.

Target G – Preliminary reporting on multi-hazard early warning system practice hints at lessons to be learned and efficiency improvements to be made in respect of analysis (data collection and risk assessment) and ensuing action (response). Greater effort is required to move beyond analysis of direct loss and damage, to understand impact more holistically. To do so requires us to look at the indicators of the post-2015 agreements afresh, across goals and targets, and establish metrics for those dimensions of disaster impacts that accrue to the most vulnerable.

Risk Reduction post-2015

All post-2015 agreements include elements of DRR and resilience in their scope – namely the Sustainable Development Goals (SDGs), 2030 Agenda, the Paris Agreement on Climate Change, the New Urban Agenda (NUA), the Addis Ababa Action Agenda (AAAA) and the Agenda for Humanity. All of them point to the interconnection of global challenges and risks.

The implementation of these agreements requires and provides the opportunity to address underlying risk drivers by fostering risk-informed investment and focusing on issues such as poorly planned urbanization, climate change, environmental degradation and poverty. In doing so, common actions will simultaneously support the achievement of the goals and targets of all agreements, including the Sendai Framework. The relevance of DRR to the post-2015 development agreements and the links among them create opportunities to: (a) build international coherence and foster risk-informed policy and decision-making; (b) promote multi-hazard and cross-sectoral approaches to assessing risk; and (c) encourage a deeper understanding of socioeconomic and environmental vulnerability across different sectors and levels of government. Though each agreement frames disaster risk and resilience from different perspectives, there is a common understanding that DRM is one of the prerequisites to building resilience. This is an imperative to achieving sustainable development and a reminder of how integrated the responses ought to be Reinforcing the point, the Secretary-General of the United Nations emphasized that DRR must be at the core of sustainable development strategies and economic policies if countries are to fulfil the commitment in the 2030 Agenda and ensure that "no one will be left behind".

3. DISASTERS AND THEIR MANAGEMENT IN INDIA

In ancient Bharat (India), the concept of disaster management existed since Vedic period. Systematic management practices are found in the Vedic literature. This literature elaborates the concept of disaster management in Kautilya's "Arthasastra." The earliest initiatives in developing an institutional mechanism for disaster management in occupied India began in 1883, with the First Famine Code formulated by a Famine Commission. After 1947 (independence from British Raj), the initial focus was on food scarcity and famine so a Scarcity Relief Division within the Ministry of Agriculture was put in charge of drought and scarcity management and gradually given the responsibility for managing all natural disasters when it was upgraded to a Natural Disaster Management Division (NDMD) within the Ministry of Agriculture. The Bhopal Gas disaster (1984) did much to focus more attention on the need for a holistic approach to technology disaster management. The government took several important measures, with major legislative changes and stronger institutional mechanisms. It set up Crisis Groups at central, state, district and local levels.

A High Powered Committee (HPC) on disaster management was established in August 1999 to recommend an institutional system for managing disasters. The committee studied the disaster management system globally and had a sense of consultations with all stakeholders. Recommendations were made in October 2001, which focused on the need for a holistic effort considering all disasters within a coordinated system of governance. It is this recommendation from the HPC that possibly provided the impetus for the Disaster Management Act, 2005, and gradual establishment of three-tier institutional mechanism by way of national to district-level authorities and funds for response and mitigation. Also, the HPC provided a model district plan. Also, it focused on instilling a culture of prevention into the national psyche. The Planning Commission of India incorporated a separate chapter on 'Disaster Management - The Development Perspective in the 10^{th} (2002-2007) and subsequent Five Year Plans" with the objective of informing, guiding, and providing specific strategies for all state Governments on disaster management.

Along side this, certain funding arrangements were put down by different Finance Commissions constituted every five years under Article 280 of the Constitution of India. The 13th Finance Commission (13FC) recommended differential State shares, with general category States contributing 25% and special category States contributing 10%, and the balance being contributed by the Union Government as grants-in-aid. The 14th Finance Commission (14FC) recommended an amount of Rs. 61,219 Crores as aggregated corpus of State Disaster Response Fund (SDRF) for all States for the award period 2015-20 with state contribution of 10% (Rs.6,122 Crores) to SDRF, the remaining 90% (Rs. 55,097 Crores) coming from Central Government. The 15th Finance Commission (15FC) has made five major breakthroughs for disaster management, namely:

(1) For the first time, it has used the word disaster risk management (ex-ante investment);

(2) It recommended long overdue Disaster Mitigation Fund along with the response fund;

(3) It included disaster preparedness and capacity building (another pre-disaster fund);

(4) It recommended allocation for post-disaster long term recovery with the assessment economic loss, direct property loss and its impact on the economy; and

(5) For the first time, it did not use expenditure-based allocation.

Certainly, these breakthroughs will give new impetus in reducing disaster risk and economic losses.

4. INDIA'S INITIATIVE IN GLOBAL IMPLEMENTATION OF THE SENDAI FRAMEWORK

India has played an important role in global initiatives on disaster management. With multi-dimensional initiatives and expertise, India is taking a leading role in strengthening regional cooperation among South Asian countries for reducing disasters. Further, India has hosted the SAARC Disaster Management Centre in New Delhi with a clear mandate for enhancing regional cooperation. India is a signatory to major global Frameworks, including Hyogo Framework of Action and Sendai Framework for Disaster Risk Reduction, and is committed to achieving the goals set under it through systematic and sustained efforts under the priority action areas mentioned in the Framework respectively. The Sendai Framework is built on elements which ensure continuity with the work done by states and other stakeholders under the HFA, and introduces a number of innovations. For India, the Framework reaffirms our commitment to address disaster risk reduction and building of resilience to disasters with a renewed sense of urgency. In furtherance to its commitment, the government has taken up several important initiatives post Sendai Declaration.

Firstly, as committed during the Sendai conference, India has successfully hosted the Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR) in November 2016 and adopted 'New Delhi Declaration' and 'Regional Action Plan for Implementation of the Sendai Framework'. In line with the all-of-society approach for disaster risk reduction enshrined in the Sendai Framework, the AMCDRR also provided an opportunity for multiple stakeholders to come together and make specific commitments to the implementation of Sendai Framework in Asia and the Pacific. These outcomes of the AMCDRR will guide the implementation of the Sendai Framework in Asia and the Pacific. On one hand, these outcomes will help contextualize Sendai Framework for Asia-Pacific, and on the other hand, these will infuse a sense of urgency with regards to its implementation in the region. At the AMCDRR, the Prime Minister of India outlined a 10-Point agenda (**Table 1**), to pursue the implementation of disaster risk reduction efforts in the region with renewed vigour.

Table 1: Indian Prime Minister's 10-Point Agenda on Disaster Risk Reduction outlined at the AMCDRR

Point	Agenda
1	Ensure that all development projects (airports, roads, canals, hospitals, schools, bridges) are built to appropriate disaster resilient standards and contribute to the resilience of communities they seek to serve. Build a coalition to support disaster resilient infrastructure.

2	Work towards risk coverage for all – starting from poor households to small and medium enterprises to multi-national corporations to nation states.
3	Encourage greater involvement and leadership of women in disaster risk management.
4	Invest in risk mapping globally for all hazards.
5	Leverage technology to enhance the efficiency of our disaster risk management efforts.
6	Development network of universities to work on disaster issues.
7	Utilize the opportunities provided by social media and mobile technologies.
8	Build on local capacity and initiative.
9	Ensure that the opportunity to learn from a disaster is not wasted. Establish a facility for technical support to post disaster reconstruction of houses.
10	Bring about greater cohesion in international response to disasters

Secondly, Government of India has issued a set of priority actions to all the State Governments based on the goals, targets and priorities of Sendai Framework 2015-2030. Government of India, during AMCDRR, 2016, has extended the grant of US$1 Million to UNISDR towards effective implementation of the Sendai Framework for Disaster Risk Reduction in the Asian region.

Thirdly, in line with Sendai priority 4, National Disaster Response Force (NDRF) is strengthened, both in terms of state-of-the-art training and equipments so as to further empower it as a professional disaster response force. Besides, Government of India has approved the creation of National Disaster Response Reserve (NDRR) through a revolving fund of Rs.250 Crores to be operated by the National Disaster Response Force. This dedicated fund would enable the NDRF to maintain a ready inventory of emergency goods and services comprising tents, medicines, food items, etc., which are immediately required after any disaster.

Fourthly, Government expressed keenness to share India's expertise and help other countries in disaster response, as it did in the aftermath of the 2011 Japan Earthquake and the 2015 Nepal earthquake. The Government of India is making consistent efforts to promote regional cooperation by hosting the SAARC Disaster Management Centre to reduce disaster risks in the region and promoting knowledge sharing among the SAARC countries. SAARC Disaster Management Exercise (SAADMEX) 2015 held in Delhi provided ideal platform for sharing the government's ideas and experience and reaffirmed its commitment to strengthen the institutional mechanism of regional cooperation on disaster response among the member countries. Similarly, the Indian National Centre for Ocean Information Services (INCOIS), in Hyderabad, provides early warning not only to India but also to 28 countries on the Indian Ocean Rim.

Lastly, while re-emphasizing that the state has a primary role in reducing the disaster risk, the Sendai Framework also calls upon other stakeholders (including the private sector) to be involved in disaster preparedness and mitigation planning as well as response and recovery phase. In the mission of Disaster Risk Reduction, there is a need of collaboration by all entities, public and private, to strengthen the mechanisms for disaster risk reduction by using and sharing of reliable and affordable modern technology for capacity building. The Government of India believes that the sustainable infrastructure should take into account all factors, including secondary hazards that resulted from rapid urbanization. The outcome documents of the AMCDRR, New Delhi, held in November 2016 is a reaffirmation of political commitments in the region, and its help in devising future strategies for identification of risks, challenges and equal distribution of scarce resources, ultimately contributing to achieve sustainable development goals.

Since the Indian Ocean Tsunami of 26 December 2004, there has been a surge of interest in developing early warning systems. But, early warning systems can be used to detect a wide range of events, such as floods, cyclones, vehicular collisions, missile launches, and disease outbreaks. India has done a commendable job in developing early warning systems with the use of technology, such as Doppler radars, telecommunication, and satellite phones. Already, India provides tsunami-warning alerts to several countries in the Indian Ocean neighbourhood, as do Australia and Japan.

The India Meteorological Department is developing a Flash Flood Guidance System to predict the threat of a flash flood. It will alert citizens and disaster relief forces in advance, preventing loss of lives and damages worth billions of rupees. Similarly, the Indian National Centre for Ocean Information Services (INCOIS), in Hyderabad, provides early warning not only to India but also to 28 countries in the Indian Ocean Rim

The Government of India has initiated the following:

(1) *National Cyclone Risk Mitigation Project (NCRMP)*: To address cyclone risks in the country, the Project is undertaking suitable structural and non-structural measures to mitigate the effects of cyclones in the coastal states and UTs of India.

(2) *Project on deployment of Mobile Radiation Detection Systems (MRDS)*: To handle Radiological Hazards in Metros/Capital Cities/Big Cities in India and to detect unclaimed radioactive materials/substances and save public from its hazardous effects, NDMA has chalked out a plan to provide States/UTs Mobile Radiation Detection Systems to be deployed in Metros/all Capital Cities and Big Cities in India and also train personnel's as 'Trainer of Trainers.'

(3) *Landslide Risk Mitigation Scheme (LRMS)*: The Scheme envisages financial support for site specific Landslide Mitigation Projects recommended by landslide prone States, covering "disaster prevention strategy, disaster mitigation and R& D in monitoring of critical Landslides" thereby leading to the development of Early Warning System and Capacity Building initiatives. The Scheme is under preparation.

(4) *Flood Risk Mitigation Scheme (FRMS)*: The Scheme is intended to cover: (a) Pilot Projects for development of model Multi-Purpose Flood Shelters, and (b) Development of River Basin Specific Flood Early Warning System and Digital Elevation Maps for preparation of Inundation Models for giving early warning to the villagers for evacuation in case of flood. Under the Scheme, financial support is to be provided to the Flood prone States for undertaking pilot scheme in respect of above two activities. The Scheme is under preparation.

5. CONCLUSION

The cultural ethos of the most vulnerable people, facing frequent disasters with little resilience and a poor quality of life, was one of fatalism and acceptance of loss as the wrath of nature (an act of God). A similar attitude prevailed within the administrative machinery too, with focus only on post-disaster relief and rehabilitation (reactive attitude). The prevalent nomenclature of the nodal officials and departments dealing with disaster management, namely relief commissioners and departments of relief, indicate the significance of relief in the administrative system. A chain of disasters brought a shift from a *relief-based* to a pro-active *preparedness and mitigation-based approach*. It was realized that the apparent loss of human life and assets masked insurmountable losses in livelihood, social capital, and economic development. Thus, the new proactive approach was and is adopted as a way of life to minimise the losses. India has come a long way in its development and sustainability strategy and the new approach adopted along with imbibing the global frameworks in its developmental policies gives it an upper hand to reduce disaster risks and losses towards ensuring a safer, resilient and sustainable future.

Bibliography

1. *GAR, (2019), Global Assessment Report on Disaster Reduction 2019, United Office for Disaster Risk Reduction*
2. *MHA, (2011), Disaster Management in India, Ministry of Home Affairs, Government of India*
3. *Rijiju,K., (2007), "Post Sendai Initiatives and Way Forward," YOJANA,*
4. *NIDM, (2019), Annual Report 2018-2019, National Institute of Disaster Management, New Delhi*

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Current Thrusts in Disaster Management in India

Abstract: Holistic disaster management is a multi-stakeholder process. Management of Covid-19 pandemic has highlighted it. While some new areas of concern are emerging, some of the issues identified in the past are still relevant. Opportunities to address them have now become available through the acceptance of recommendations of 15th Finance Commission for the first year. Capacity building of all concerned is the need of the hour. Participation of the communities is the key in addressing the current thrusts effectively.

Key words: Holistic disaster management; Capacity building; Ten point agenda on disaster risk management

1. INTRODUCTION

It is necessary to examine the journey so far after the *Disaster Management Act, 2005*, came into force to appreciate the current thrust areas. Some of the important improvements are summarised hereunder.

India has developed a robust institutional structure with statutory backing. It is not a merely a matter of control that the subject of disaster management changed from the Agriculture Ministry to the Ministry of Home Affairs by an amendment of the Rules of allocation of business. Fundamentally, three important changes have been brought in: The emphasis shifted decisively from the 'relief-centric' approach to a holistic one. Disaster Risk Reduction (DRR) is the key. No longer are we to confine any discourse on 'disaster management' by confining to the good old three R's of rescue, relief and rehabilitation, as the scope has increased to cover disaster risk reduction, preparedness, capacity building, holding of mock exercises, recovery and reconstruction, including restoration of livelihoods. The second important change is that statutory responsibilities in Disaster Management (DM) were given to every Ministry or Department of Government of India and to every State Government. The third change is that Institutions (like National Disaster Management Authority (NDMA), National Disaster Response Force (NDRF) and National Institute of Disaster Management (NIDM) with corresponding structures in the States) have been functioning with clear mandate. DM is primarily with the State Governments, as per *National Disaster Management Policy, 2009*.

Significant improvements have taken place in preparedness in different States, as can be seen from massive construction of multi-purpose cyclone shelters in coastal States, with community participation in their upkeep, better equipment of State Emergency Operation Centers and more detailed exercises in drawing up response plans at district and State levels. Higher financial resources are being spent in disaster response, as can be seen from the fact that the overall allocation under State Disaster Response Fund, which was Rs.21,333 Crores in the form of 'Calamity Relief Fund' in 2005-10 increased to Rs.33,581 Crores for 2010-15 and to Rs.61,220 Crores for 2015-20. Similarly, the releases from the 'National Calamity Contingency Fund' during 2000-05 were to the tune of Rs.10,938 Crores. The release from the National Disaster Response Fund during 2005-10 were Rs.17,559 Crores and during 2010-15, the releases were Rs 57,146 Crores. The increasing expenditure in response funds highlights the need for strengthening the monitoring mechanism in different States for effective realisation of the outcomes. It highlights the need to focus more attention on risk identification and mitigation activities well in time, which could make a dent in the very rationale for high financial allocation for response and reconstruction.

Technological advances in developing early warning systems have brought in significant improvements in the accuracy as well as lead time in issuing the alerts in case of many hazards, with particular mention of cyclones. Induction of Doppler Weather

Radars, coupled with development and use of various technology applications by the India Meterological Department, has resulted in significant improvement in the quality and accuracy of advance weather warnings. The state-of-the-art facility at *Indian National Centre for Ocean Information Services* (INCOIS) has added a new dimension to the contribution of India in Tsunami warning capabilities not only to different parts of India but also to 22 countries in the region. NDRF has emerged as the largest specialised force in the world, with 12 Battalions now, with personnel that are adequately equipped and trained, with remarkably good ground level performance in search and rescue. Four more battalions are going to be added soon. Outreach campaigns have increased both in number and in diversity of methodologies by use of various technology and communication platforms on what a person should do before, during and after a disaster [NDMA, 2019d]. The involvement of communities and civil society organisations at the grassroots in DM has increased significantly across the States.

By and large, with the active involvement of all stakeholders, mortality figures in disasters have been reduced, if we exclude the ongoing Covid 19 pandemic as an outlier event. A noteworthy point in this regard is the manner in which mortalities due heat waves have been reduced significantly through diligent participation of all stakeholder agencies and special thrust given by NDMA. In the year 2015, we lost 2,040 human lives due to heat wave. The number came down to 1,111 in 2016, 384 in 2017 and 25 in 2018 [NDMA, 2019a]. There was an increase to 215 in 2019, a year in which different parts of India witnessed intense and prolonged heat waves. NDMA issued national guidelines for preparation of Action Plan for Prevention and Management of Heat-Wave in April 2016 to provide a framework for implementation, coordination and evaluation of extreme heat wave related activities in the country [NDMA, 2016]. These Guidelines were revised further in 2017 and 2019. They assisted concerned central Ministries and Departments, States, districts and cities to prepare and update their Heat Action Plans. Also, these guidelines list long-term mitigation measures to address the key issues at a broader level by highlighting activities to be undertaken by States and Local

Authorities in their respective areas to reduce the negative impact of extreme heat wave conditions. The State Governments prepared and acted upon the action plans, through involvement of different departments and the civil society, supported by necessary awareness generation activities. The number of lives lost due to heat wave in 2020 has remained in single digits. Similar focus is being attempted for better preparedness in respect of other hazards including thunderstorms and lightning.

Focus is being given to cultural heritage sites in disaster preparedness. NDMA has released guidelines on cultural heritage sites and precincts in 2017 [NDMA, 2017]. The exercise conducted in 2019 among the countries of BIMSTEC at Konark in Odisha looked into account these aspects. Similarly, work is underway with regard to disaster preparedness of museums. Similarly, protection of manuscripts is being taken up in a Mission mode. Urban flood forecasting and dissemination of alerts has assumed an important dimension in recent areas. NDMA with partnership of TERI and Guwahati Municipal Corporation has developed a decision support system to deal with floods in Guwahati. NIDM expanded its training activities in a significant way in recent years (**Table 1**).

Table 1: Details of Training Programs conducted from 2016-17 to 2020-21 [*Source:* NIDM]

Year	Programs conducted	Number of Participants
2016-17	44	1,429
2017-18	46	1,393
2018-19	52	1,723
2019-20	100	5,646
2020-21 (Webinars)*	193	45,816
2020-21 (Training Programs)*	62	16,075
* Organised till Sept 2020		

During the recent years, the activities of NDRF increased manifold. It took part in international exercises, including Shanghai Cooperation Organisation and BIMSTEC. Some of the search and rescue activities for which the Force has earned laurels in recent years, include 2014 J&K floods, 2015 Nepal earthquake, 2016 Kolkata flyover collapse, 2019 Savitri Mahad bridge collapse, and 2019 Mahalaxmi express incident (Thane).

1.1 Prime Minister's agenda on disaster risk management

It is relevant to note the Prime Minister's ten point agenda on disaster risk management, made at the Asian Ministerial Conference on Disaster Risk Reduction in 2016. Though meant primarily for an international audience, it is a succinct enunciation of domestic thrust areas too. The agenda points were [AMCDRR, 2016]:

(1) All development sectors must imbibe the principles of disaster risk management.

(2) Risk coverage must include all, starting from poor households to SMEs to multi-national corporations to nation states.

(3) Women's leadership and greater involvement should be central to disaster risk management.

(4) Invest in risk mapping globally to improve global understanding of nature and disaster risks.

(5) Leverage technology to enhance the efficiency of disaster risk management efforts.

(6) Develop a network of universities to work on disaster-related issues.

(7) Utilise the opportunities provided by social media and mobile technologies for disaster risk reduction.

(8) Build on local capacity and initiative to enhance disaster risk reduction.

(9) Make use of every opportunity to learn from disasters and, to achieve that, there must be studies on the lessons after every disaster.

(10) Bring about greater cohesion in international response to disasters.

As may be seen, these action points involve different stakeholders including Government agencies at the Centre and the States, scientific organisations, academia and the civil society. One of the most important challenges in the Government system has always been how to translate lofty policy pronouncements into ground level action. It needs to be noted that *National Disaster Management Plan, 2019*, highlights these ten points. Therefore, it is required that all central Ministries and State Governments take into account these thrust areas while drawing up their holistic disaster management plans, as per Section 37 and 38 of the Disaster Management Act, 2005. And, it is clear that there is statutory backing for taking up these measures. Regarding training and sensitisation of the officials, NDMA and NIDM have organised series of webinars on each of these points, with high level of participation by various agencies. Training programs are being organised with nodal officers of various central Ministries [NDMI, 2019b]. The ongoing set of activities on these agenda points need to reach the last mile in terms of making a concrete difference in the work at grass roots level, with active participation of the State Governments.

The agenda point 1 can be best served by having a carefully drawn proforma by which Ministries and Departments furnish their proposals for new investments, to see that the proposed investment is in line with the disaster risk reduction requirement and that it would not add to the existing vulnerabilities. Agenda point 2 would involve several action points including exploring risk transfer mechanisms, on which several rounds of consultations have taken place between the disaster management sector and the insurance sector. Agenda point 3 would require multiple stakeholders and several measures including having more women personnel in NDRF Battalions.

2. UTILISATION OF THE AWARD OF 15TH FINANCE COMMISSION

There has been a long-felt need to give focus to mitigation activities. The DM Act, 2005, provided for constitution of Mitigation Fund at the National and State levels. The historic recommendations of the 15th Finance Commission for the year 2020-21 in this regard have been accepted by the Union Government, paving the way for special focus on mitigation or disaster risk reduction [15FC, 2020]. Separate funding windows for mitigation, preparedness & capacity building, response and for recovery & reconstruction have been provided. A total allocation of Rs.41,373 Crores has been accepted at the National level and the State level for all these four windows, under the umbrella of disaster risk management. Guidelines for utilisation of the windows for mitigation and preparedness and capacity building are expected to be notified soon. Therefore, it is imperative to enhance the capacities at the National, State and district levels to utilise these new opportunities.

3. TASKS RELATING TO COVID 19

While it is beyond the scope of the present article to look into all aspects of management of Covid 19, it is necessary to see how the existing legal framework has been utilised and how the health authorities and disaster management streams have been working together. NDMA has brought out Guidelines on Management of Biological Disasters in 2008 [NDMA, 2008]. National Disaster Management Plan, 2019, provided a responsibility matrix regarding biological and public health emergencies [NDMA, 2019c]. The primary response challenge with regard to Covid 19 is being shouldered by the Health Departments of the State Governments, coordinated and supported by the Ministry of Health and Family Welfare in Government of India. Doctors and front line health workers have stretched their capacities to meet the challenge. An account has been prepared of efforts made by different stakeholders in the first phase of the pandemic [NDMA, 2020a].

NDMA in its communication dated 4 February, 2020, suggested to the States on the need to promote advisories on hygiene, avoiding crowd contact, use of personal protection equipment, masks and hand sanitizers [NDMA, 2020b]. Members and Officers of NDMA visited the States and interacted with the State Governments during February and March on the need for various non-medical and non-pharmacological interventions. Further advisories were issued by NDMA to the States on 5 March 2020 and 17 March

2020. On 21 March 2020, the powers conferred by Section 6(2)(i) of the Disaster Management Act, 2005, were invoked for the first time when the nation-wide lock down order was issued. NDMA organised consultations with civil society organisations and brought out a number of advisories and Information, Education and Communication(IEC) material on wearing masks, hand hygiene and physical distancing. The powers of the National Executive Committee under the DM Act, 2005, have been delegated to the Secretary, Ministry of Health and Family Welfare. Also, most States have relied on the Epidemic Diseases Act, 1897, for enforcing various provisions relating to violation of hygiene, physical distancing and wearing masks and to enable necessary collection of fine.

A remarkable effort is to reach out persons tested Covid 19 positive, to extend support of psychosocial care in a proactive manner through trained counselors [NDMA, 2020c]. While the medical personnel are attending to serious patients in the hospitals, the current challenges outside include effective communication to all sections of society on appropriate behavior to reduce the spread of the pandemic.

4. SOME IMPORTANT EMERGING AREAS

Some of the emerging areas are as follows:

(1) Digital Elevation Model (DEM) is essential in accurate forecasting of river inundation. A new opportunity has been utilised by partnership between Central Water Commission and Google India, by obtaining the DEM with high resolution through machine learning tools that generate flood warning alerts with more spatial accuracy and reliability [GI, 2020a]. Field testing and validation of this work is in progress [GI, 2020b].

(2) India Meterological Department has done remarkably well in giving cyclone warnings. To further boost these efforts, a decision support system is being developed with the partnership of IMD, INCOIS and private sector, facilitated by NDMA. India has done well in terms of reducing mortalities by evacuating large number of people living in the coastal areas, based on advance warnings generated by IMD with reasonably high accuracy. But,

the critical questions (like whether everybody living in coastal area need to be evacuated, whether only people living in semi pucca houses need to be shifted and what level of wind speeds can be resisted by the existing infrastructure?) can be answered only by doing detailed analysis in the pre-cyclone period.

(3) Thunderstorm and lightning is an area that has received considerable attention in recent years. A need has been identified for structural and non-structural mitigation measures. It is expected that with the activation of the necessary funding window, the vulnerable States will be able to take up the measures. Meanwhile, timely dissemination of alerts through sms messages and through various Apps have been developed with the partnership of private sector by different States.

(4) Geospatial technologies are being used increasingly on various aspects of disaster management. With particular reference to Covid, Ministry of Health has developed an elaborate system of capturing data from the field units. NDMA has developed a district-wise risk index based on multiple parameters and shared it with the States, which was found useful in the initial period [NDMA, 2020d]. Arogyasetu is a good example of how new technology options have been tried to address the challenge. Another GIS-based system was developed in NDMA to assist migrant workers moving across different States in India following the initial lock down measures. Another GIS-based software application has been developed to monitor availability of medical oxygen in different Covid hospitals across the country. Forest Survey of India has developed geospatial application based on spectro-radiometer sensor aboard satellite to generate alerts on forest fire [FSI, 2020].

(5) Drones are increasingly being used in various aspects of disaster management. With a clear regulatory mechanism now in place, this technology promises to be of greater application in diverse areas, like rescue efforts during floods, landslide and alert generation in forest fires.

(6) Multi-hazard risk and vulnerability analysis have huge potential in enabling optimum deployment of resources for mitigation

activities. NDMA has commissioned a study in this regard in Kerala and Mizoram. Though the technology *per se* is not new, different methodologies are required for undertaking these analyses for different hazards. Utilising the findings of such studies for development planning purposes is an important, continuing concern.

(7) Building Materials and Technology Promotion Council (BMTPC) has released the third revision of the Vulnerability Atlas of India, which as potential in development planning in various areas, with particular reference to housing. Also, it has developed an e-Course to develop awareness on using this resource [BMTPC, 2020].

(8) Pilot project of Common Alerting Protocol has been launched in Tamil Nadu. It uses dissemination of alert *sms* messages in Tamil language. The up-scaling of the project for the whole country involves ability to disseminate location specific alerts through other media, including television, radio, railways and national highways, apart from sms messages.

5. THE WAY AHEAD…

The need to continue the ongoing efforts by all stakeholders on the identified thrust areas cannot be over-emphasised. To derive clear results on the ground, coordinated measures are required with the State Governments. Demystification of Science and Technology solutions, promotion of impact based forecasting, eGovernance solutions for enforcement of necessary techno-legal regime dealing with building plan approvals or land utilisation plans that could ensure proper utilization of hazard risk and vulnerability analysis in development planning, involvement of Institutes and Universities in research studies relating to different aspects of disaster management, systematic efforts in monitoring the progress of implementation of various hazard-specific guidelines of NDMA and location specific dissemination of alerts are the need of the hour.

Synergy among various stakeholders should be maintained, while preparing for the effective utilisation of the opportunity provided by the acceptance of the recommendations of the 15th

Finance Commission for the first year. Also, it is to be noted that some old concerns still remain as relevant thrust areas even now, like mainstreaming DM into development planning. Capacity building of the officials concerned, involvement of civil society and participation of the communities would be the most important ingredients to ensure that the vision of disaster resilient India is realised at the earliest.

References

1. 15FC, (2020), Report of the 15th Finance Commission, Government of India

   https://fincomindia.nic.in/writereaddata/html_en_files/oldcommission_html/fincom15/XVFC_202021%20Report_English_Web.pdf

   Accessed on 20 November 2020

2. AMCDRR, (2016), Asian Ministerial Conference on Disaster Risk Reduction, NDM India

   https://www.ndmindia.nic.in/images/Prime%20Minister%E2%80%99s%20address%20at%20Asian%20Ministerial%20Conference%20on%20Disaster%20Risk%20Reduction.pdf

   Accessed on 06 November 2020

3. BMTPC, (2020), e-Course on the Vulnerability Atlas of India, Building Materials and Technology Promotion Council, New Delhi

   https://bmtpc.org/topics.aspx?mid=56&Mid1=528

   Accessed on 06 November 2020

4. FSI, (2020), Geospatial tools for detecting fires, Forest Survey of India *http://117.239.115.44:90/fsi_fire/fire.html*

   Accessed on 06 November 2020

5. GI, (2020a), Use of Digital Elevation Model to Generate Flood Warning Alerts, Google India

   https://ai.googleblog.com/2019/09/an-inside-look-at-flood-forecasting.html

   Accessed on 06 November 2020

6. GI, (2020b), Validation the use of Digital Elevation Model to Generate Flood Warning Alerts, Google India

   https://datastudio.google.com/reporting/fa777406-0aea-4ca6-b0c5-066a090095a0/page/CpieB?s=utRiPBE5kFE

   Accessed on 06 November 2020

7. NDMA, (2008), National Disaster Management Guidelines on Biological Disasters, National Disaster Management Authority, Government of India

https://ndma.gov.in/sites/default/files/PDF/Guidelines/biological_disasters.pdf

Accessed on 06 November 2020

8. NDMA, (2016), National Disaster Management Guidelines for Prevention and Management of Heat Waves, National Disaster Management Authority, Government of India https://ndma.gov.in/sites/default/files/PDF/Guidelines/heatwaveguidelines.pdf

Accessed on 06 November 2020

9. NDMA, (2017), National Disaster Management Guidelines for Cultural-Heritage, National Disaster Management Authority, Government of India

https://ndma.gov.in/sites/default/files/PDF/Guidelines/Guidelines-museum.pdf

Accessed on 06 November 2020

10. NDMA, (2019a), Report on Heat Waves, National Disaster Management Authority, Government of India

https://ndma.gov.in/sites/default/files/PDF/Reports/heatwave-report-dec2019.pdf

Accessed on 06 November 2020

11. NDMI, (2019b), Report of Sensitization Workshop for Nodal Officers Disaster Management in all Ministries and Departments of the Central Government

https://www.ndmindia.nic.in/presentations-sensitisation-workshop-for-nodal-officers-disaster-management-in-all-ministriesdepartments-of-the-central-government-10th-11th-october-2019

Accessed on 06 November 2020

12. NDMA, (2019c), National Disaster Management Plan, National Disaster Management Authority, Government of India

https://ndma.gov.in/index.php/sites/default/files/PDF/ndmp-2019.pdf

Accessed on 06 November 2020

13. NDMA, (2019d), Do's and Don'ts Pocket Book, National Disaster Management Authority, Government of India

https://ndma.gov.in/Publication/Pocketbook-Dos-Donts

Accessed on 06 November 2020

14. NDMA, (2020a), Report on Covid 19, National Disaster Management Authority, Government of India

https://ndma.gov.in/sites/default/files/PDF/covid/COVID-19-Indian-Experience.pdf

Accessed on 06 November 2020

15. NDMA, (2020b), Communication to the States regarding Covid 19, National Disaster Management Authority, Government of India

    https://ndma.gov.in/sites/default/files/PDF/covid/04022020.pdf

    Accessed on 06 November 2020

16. NDMA, (2020c), Pyscho-social Care through Counselors during Covid 19, National Disaster Management Authority, Government of India

    https://ndma.gov.in/sites/default/files/PDF/covid/PS-Doc-Eng.pdf

    Accessed on 06 November 2020

17. NDMA, (2020d), District-wise Risk Index related to Covid 19, National Disaster Management Authority, Government of India

    https://gis-dm.ndma.gov.in/portal/apps/sites/#/covid

    Accessed on 06 November 2020

Kamal Kishore

Coalition for Disaster Resilient Infrastructure

Abstract: Infrastructure is a key driver of sustainable development, economic growth and prosperity. The world will make large investments in new infrastructure in the coming decades. Inevitably, these investments will be exposed to a range of natural hazards — geophysical as well as hydro-meteorological. Due to climate change, risk analyses based on past hydro-meteorological events will not be sufficient for planning the future. Making infrastructure disaster and climate resilient is a global challenge concerning both developed and developing countries. The Coalition for Disaster Resilient Infrastructure provides a global platform for knowledge exchange and capacity development to facilitate the development of resilient infrastructure.

Key words: Disaster Resilient Infrastructure, Sustainable Development Goals, Climate Change Adaptation, Disaster Risk Management, Sendai Framework

1. RESILIENT INFRASTRUCTURE, SUSTAINABLE DEVELOPMENT, AND DISASTER RISK REDUCTION

Investment in infrastructure is recognized universally as a key driver of sustainable development, economic growth and prosperity. The Sustainable Development Goals (SDGs) adopted by the world community in 2015 have a dedicated goal (SDG 9) focused on industry, innovation and infrastructure. The first target under SDG9 is focused on "quality, reliable, sustainable and *resilient* infrastructure, including regional and trans-border infrastructure." The global infrastructure investment needs for the period 2016 to 2040 are estimated to be

US$ 94 trillion. Of this, G20 countries also would require US$ 69 trillion or nearly 73% of the global requirement [GIH, 2017]. In Asia and Pacific alone, according to an ADB report published in 2017, US$1.7 trillion will need to be invested in infrastructure development annually till 2040 to meet the current need and demand. This includes $200 billion per year for ensuring that the new infrastructure meets with disaster and climate resilient standards. This represents 13% additional expenditure to make all new infrastructure resilient. This would be money well spent in securing our future.

While the importance of greater investment in infrastructure is recognized globally, this is accompanied by ever increasing infrastructure losses from disasters. Disaster losses are rising globally. At US$ 340 billion, overall disaster losses in 2017 were second highest in human history. Only the record year of 2011, with losses of US$ 350 billion largely due to the Tohoku earthquake in Japan and floods in Thailand, registered higher losses [MR, 2017]. Although these losses are not related only to infrastructure, a large proportion (sometimes up to 66%) of the public sector losses are related to infrastructure losses.

As new infrastructure is developed, a large part of it will inevitably be exposed to a plethora of natural hazards including floods, earthquakes, storms, and tsunamis. If not planned properly, the new infrastructure may itself create disaster risks. Infrastructure projects are by definition long-term investments. Over the life cycle of a particular infrastructure, hazard patterns may change. The effects of climate change in terms of increasing frequency and intensity of hydro-meteorological hazards will pose an additional challenge. Past experience indicates that when infrastructure is not built to appropriate standards, disasters can exact a heavy toll not only in terms of direct damage to infrastructure but also in the form of productivity losses.

Recognition for the need to reduce damages and losses to infrastructure is reflected in the Sendai Framework for Disaster Risk Reduction (SFDRR) adopted by 187 countries, including India in 2015. One of its seven targets (Sendai Target D) aims to "substantially reduce disaster damage to critical infrastructure and disruption of basic services." Within the context of SFDRR, it is important to note the centrality of Target D pertaining to critical infrastructure. Reduction of disaster damages and losses to infrastructure will not only help achieve Target D but will also pave the way for achievement of SFDRR's other loss reduction targets (i.e., reduction in mortality, number of affected people, and economic losses).

Also, the critical importance of resilient infrastructure has been recognized by economic groupings such as G20. The group supports a Global Infrastructure Hub as a knowledge sharing network and provider of a consolidated database on ongoing and projected infrastructure investments. G20 has adopted a Road Map to promote infrastructure as an asset class.

2. DISASTER RISK AND INFRASTRUCTURE DEVELOPMENT

The damages and losses to infrastructure emanating from disasters in extreme years, such as 2011, tell only part of the story. The *risk* of damages and losses to infrastructure, although not yet quantified, is likely to be much higher. For example, **Table 1** provides an estimate of probable Annual Average Loss (AAL) from multiple natural hazards in all the G20 countries. The total probable AAL for the 19 countries listed in the table is $218 billion. When seen as a proportion of annual average investment (current trend) in infrastructure, the risk of disaster losses in G20 countries is extremely high. For all the G20 countries taken together, probable AAL is 9% of average annual investment in infrastructure. In some countries this proportion is as high as 40%. But, all of these probable AAL will not emanate from damage to infrastructure, but a large proportion would. Therefore, comparison between probable AAL and annual investment in infrastructure is a useful metric to understand the level of risk. Also, it underlines the importance of getting infrastructure investments right in terms of risk mitigation.

3. INVESTING IN DISASTER RESILIENT INFRASTRUCTURE

The above discussion makes a case for investing in disaster resilient infrastructure. This is essential for meeting the commitments under all the three post-2015 development frameworks, like the

SDGs, the Paris Agreement on Climate Change, and the SFDRR. None of the four loss reduction targets enshrined in the Sendai Framework (namely the reduction in disaster mortality, reduction in number of people affected by disasters, reduction in economic losses, reduction in infrastructure losses) can be met unless investment is made in making all infrastructure disaster resilient.

Table 1: Infrastructure Investment and Disaster Risk in G20

Country	Infrastructure Investment (2016-2040) (US$ Billion) [GIH, 2017]		Disaster Risk (Probable Annual Average Loss from Multi-hazards) (US$ Billion) [UN, 2015]	Probable Annual Average Loss (AAL) as proportion of annual investment in infrastructure
	Current Trends	Needed		
Argentina	452	810	1.99	11%
Australia	1,500	1,700	5.52	9%
Brazil	1,500	2,700	4.51	8%
Canada	1,200	1,200	3.21	7%
China	26,000	28,000	31.94	3%
France	1,800	1,800	3.59	5%
Germany	1,500	1,500	5.05	8%
India	3,900	4,500	9.82	6%
Indonesia	1,600	1,700	3.57	6%
Italy	1,200	1,600	10.55	22%
Japan	3,800	3,800	61.53	40%
RoK	1,400	1,400	9.99	18%
Mexico	522	1,100	2.94	14%
Russia	1,100	1,800	5.30	12%
Saudi Arabia	499	613	0.16	1%
South Africa	289	441	1.51	13%
Turkey	569	975	2.50	11%
UK	1,700	1,800	1.76	3%
USA	8,500	12,000	52.63	15%
Total	59,031	69,439	218.00	9%

Making infrastructure disaster resilient would require multi-disciplinary efforts involving expertise from climate science, geophysics, geotechnical engineering, structural engineering, finance, insurance, disaster risk reduction, economics, public finance management and social sciences. The spectrum of actions that need to be undertaken for disaster resilient infrastructure may be divided in four broad categories:

(1) **Assessing Disaster Risk**: This includes assessing risk of direct damage to infrastructure from natural hazards on a range of timescales, from a few years to multiple decades. Another aspect would be assessing the risk of losses emanating from full or partial disruption in the functionality of infrastructure due to natural hazards. Methods for modeling such risks are well established and continuously improving. These are applied widely in the risk management industry. But, climate change and uncertainties associated with its local level manifestation pose an additional layer of complexity in assessing risk. This presents unique challenges for developing risk metrics and indicators for the sustainability of infrastructure.

(2) **Standards of design and implementation, and good risk management practices in infrastructure projects**: The standards of design, code provisions, etc., have to keep pace with the state-of-the-art understanding of natural hazards, as well as advancements in engineering technologies to ensure that all new investment in infrastructure projects is made to the best possible standards.

(3) **Financing New Infrastructure and Mechanisms for Covering Risks**: Infrastructure projects require large capital investments. There is a role for financiers of infrastructure projects to ensure that all new projects are based on a scientific assessment of disaster risk and adhere to best design standards for managing that risk. At the same time, some of the risk of losses from low-frequency, high impact events has to be covered through insurance mechanisms. There are opportunities for innovation in this regard through development of risk pools for different infrastructure classes.

(4) **Mechanisms for supporting recovery in infrastructure sectors after disasters**: At present after major disasters assessment of damages and losses is carried out using internationally accepted methodologies. Recovery is financed through loans from multi-lateral development banks or central funds of the national governments. There are hardly any predictable mechanisms to support recovery of infrastructure after moderate to small-scale disaster events. A predictable mechanism to support recovery in infrastructure sectors will not only facilitate swift recovery but also ensure minimum disruption of services

A comprehensive approach to disaster resilient infrastructure will require action under all of the above categories.

4. NEED FOR GLOBAL COOPERATION TO PROMOTE DISASTER RESILIENT INFRASTRUCTURE

The problem of disaster resilient infrastructure is not a challenge for developing countries. All countries of the world – those with advanced infrastructure systems, those with rapidly developing infrastructure, as well as those with large infrastructure deficits can benefit from collaboration. Countries with advanced infrastructure systems, such as the United States and the United Kingdom, need to replace the infrastructure that is completing its life cycle. They have the opportunity to learn from countries with more recent experiences and innovations. Similarly, countries with a large infrastructure pipeline, like India, can benefit from other countries to manage the infrastructure growth in a manner that it leads to sustainable and resilient infrastructure. In addition to this, there are two other points of rationale for global collaboration in this space. First, the global infrastructure systems (as has become evident during COVID 19) are increasingly inter-connected and inter-dependent. For example, the shipping industry is only as resilient as the weakest node in the global network. And, second, the financial flows that underpin infrastructure development increasingly are transcending national boundaries.

It is in this context that the Prime Minister of India announced the Coalition for Disaster Resilient Infrastructure (CDRI) in September

2019. The CDRI is a forward looking initiative that addresses the common challenge of building resilience into infrastructure systems, particularly in the context of increasing disaster risk due to climate change. It serves as a platform where knowledge is generated and exchanged on different aspects of disaster resilience of infrastructure. It brings together a multitude of stakeholders (namely governments, private sector, academic research institutions and international organizations) and aims to assist countries upgrade their capacities, standards, regulations and practices with regards to infrastructure development in accordance with their disaster risk context and their economic needs.

At present, the CDRI, co-led by India and the United Kingdom, has 18 nations and 4 international organizations as its members. The CDRI is served by a Secretariat based in New Delhi. The CDRI has a multi-year work plan, which will culminate in 2022, coinciding with the mid-term review of the SDGs, SFDRR and the Paris Agreement on Climate Change. The CDRI's work over the coming years may be summarized as follows:

(a) Short Term:

Knowledge exchange of existing practices among partner countries on disaster risk management in key infrastructure sectors. Towards this end, the CDRI secretariat hosts a virtual knowledge platform and also organizes an annual knowledge event.

(b) Medium Term:

Undertake multi-disciplinary action research through the participation of academics and practitioners engaged in different aspects of infrastructure development and disaster risk management in G20 countries. The action research is organized around following main sub-themes:

(i) Development of risk assessment methodologies, risk metrics and indicators of sustainability for different infrastructure classes;

(ii) Issues of standards, design and regulation for infrastructure development, operations and maintenance;

(iii) Financing for disaster resilient infrastructure including risk transfer mechanisms; and

(iv) Reconstruction and recovery of key infrastructure sectors after disasters.

(c) Long Term:

Over the long term, work on disaster resilient infrastructure would require an expanded coalition of other countries and partners. In addition to expansion of activities initiated over the short and medium term, the coalition could establish an **innovation fund** that would provide grants to test or demonstrate new technologies for infrastructure design as well as management systems around it. Based on multi-disciplinary research as well as development of innovations, countries can develop and implement collaborative solutions to address problems of common interest to partners. For example, a set of countries could work on development of a regional risk pool for certain infrastructure class such as airports. After major disasters, the fund may also support swift reconstruction and recovery of **critical** infrastructure to improved standards of disaster resilience (Build Back Better).

References

1. GIH, (2017), Infrastructure Outlook, Global Infrastructure Hub, Sydney
2. GIH, (2017), Infrastructure Outlook, Global Infrastructure Hub, Sydney
3. Munich Re, (2017), Topics GEO Natural Catastrophes, Munich
4. UN, (2015), Global Assessment Report, United Nations

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Developing National Capacity towards Disaster Management

Abstract: To develop national capacity there is a need to go beyond national institutions to develop the capacity of all key stakeholders. While there is a unanimous agreement on the need for capacity development for Disaster Risk Reduction (DRR), the complexities involved are not properly addressed. In addition to institutional capacity development, there is a need to focus on the capacity development of the recipient communities. There is also a need to shift the focus of capacity development initiatives from preparedness and response to mitigation and resilience This article examines the issues and challenges in capacity building for sustainable DRR.

Key words: Capacity Development, Sustainable Risk Reduction, Community Capacity, Capacity of Local Bodies, National Capacity

1. INTRODUCTION

The old adage "the spirit is willing but the flesh is weak" essentially captures the existing capacity gap between the intention of the national governments as reflected in their legal framework, policies, plans and the translation of these into sustainable Disaster Risk Reduction (DRR). The Sendai Framework for Disaster Risk Reduction (SFDRR) emphasizes on the need for capacity development (CD) as one of the necessary conditions for achieving the seven targets set up in the framework. The SFDRR calls for building capacity at the national and local levels through national as well as International, regional, sub-regional and trans-boundary cooperation [UNISDR, 2015]. As pointed out in literature [Scott and Few, 2016], "A call for action does not necessarily reflect the complexities of how such capacity development should be undertaken, for whom, how and with what expected outcome." It is the responsibility of the national governments committed to implementing the framework to understand, plan and implement CD programs to achieve the Sendai targets.

India's capacity for disaster risk management is often challenged by low frequency-high impact, as well as low impact-high frequency disasters. India is one of the most disaster-prone countries in the World [GoI, 2011; Nambiar, 2015], on account of the size, population, concentration of assets and people, geographic diversity, agro-climatic conditions and unequal development across the states. India is ranked fifth among the 10 worst affected countries in extreme weather events by Germanwatch [Germanwatch, 2019]. India lost about 26,000 lives and suffered a damage of INR 5,38,83,807 Lakhs due to natural disasters in the decade 2011-2020. Analysis of the disaster losses since 2001 shows that, though India has, over the years, been able to reduce loss of lives, economic losses have been mounting [Guha-Sapir *et al*, 2016].

While management of catastrophic disasters, particularly cyclones has highlighted India's improved ability to early warn, evacuate people and respond to disasters [UNDRR 2013; UNDRR 2015], it has exposed also the need to build capacity for sustainable disaster reduction and enhancing mitigation. The current COVID 19 Pandemic is emerging as a major challenge to the competency and capacity of not only the health system, but also to the disaster governance system, calling into question every aspect from policy framework to implementation at the local level.

The dynamic nature of risk makes CD a moving target. CD happens over time [Scott and Few, 2016] and cannot be a one-time activity. The National Disaster Management Plan (NDMP) points out that "Investing in capacity development for DRR is a continuing process of enhancing the capability of individuals, agencies, and communities to improve the performance of their DM functions" [NDMA, 2019a]. The shift from disaster response to mainstreaming risk reduction warrants a shift from aiming at CD of the institutions and individuals directly concerned with managing disasters to improving disaster risk governance. In short, CD at national level is essential, which includes all stakeholders and all levels. It must aim at the creation of an enabling environment for managing all phases of the disaster cycle.

This paper examines the capacity of the existing institutional mechanisms, legal and policy instruments, roles of the stake holders vis-à-vis the challenges for DRR at various levels. Drawing from international experiences, it will provide an approach for bridging the capacity gap. The Section 2 that follows the introductory Section will review the literature concerned. Section 3 deals with the legal framework and institutional mechanisms for CD. Section 4 analyzes the capacity gaps, issues and challenges. And, Section 5 draws applicable inferences.

2. CAPACITY DEVELOPMENT: RHETORIC AND REALITY

Solutions emerge from correct identification of the problems. We must ask: what CD is and whose capacity should we develop? To improve the approach and prioritize interventions, one needs to analyze the outcomes of three decades of CD efforts in India and study the research findings within national and international contexts. The term CD does not have a universally agreed definition. Some authors maintain distinction between development and building; others use them interchangeably [Scott and Few, 2016]. “While ‘capacity-building’ suggests building something new from the ground up, according to a pre-imposed design, ‘capacity development’ is believed to better express an approach that builds on existing skills and knowledge, driving a dynamic and flexible process of change, borne by local actors” [Zamfir, 2017]. In this paper, the terms are used interchangeably.

United Nations Office for DRR (UNDRR) defines capacity development for DRR as: “Capacity development is the process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals. It is a concept that extends the term of capacity-building to encompass all aspects of creating and sustaining capacity growth over time. It involves learning and various types of training, and continuous efforts to develop institutions, political awareness, financial resources, technology systems and the wider enabling environment [UNDRR 2016]."

While we discuss the capacity for DRR, many questions need to be answered: "Is it because disasters are unique and pose a challenge that cannot be effectively managed by human societies? Is it dependent on a country's economic well-being? Or is it because of the way capacity development for disaster risk management is taking place — in other words the design and implementation of capacity building programs are not good enough?" [Tiwari 2015].

CD goes beyond acquisition of skills to the capability to use them. CD should be demand driven [Scott and Few, 2016] and should be addressed at the level of individuals, organizations, institutional level and the society [Fukuda-Parr et al, 2002; Scott and Few 2016] to create an enabling environment [CaDRi, 2011]. The enabling environment must go beyond knowledge transfer and skill building and improve the functioning of the organizations, which is transformation of structural relationships and exercise of power in Institutions [Fukuda-Parr et al, 2002]. "Capacity development includes but is not limited to training. Significant non-training factors such as policy, strategy, work culture, enabling environment, infrastructure and finance have a major bearing on capacity to perform and produce results" [SEEDS and Knowledge Links, 2014].

Literature points out several short comings in CD programs. Most of the CD programs are top-driven [Tiwari 2015; SEEDS and Knowledge Links, 2014], supply driven and are short-term training programs [Tiwari, 2015], focus mainly on training individuals without addressing the needs of organizations, address structural issues and coordination between various organizations [Hagelsteen and Becker, 2013]. Adequate attention has not been paid to improving the capacity for policy making [Scott and Few, 2016].

Research on CD for DRR has several gaps. While the top-down approach is criticized as one of the main reasons for the failure of CD exercises, there is not much of research or study which informs the correct approach and how a bottom-up approach should be carried out to build sustainable capacity. Literature is short of success stories of such CD leading to sustainable DRR. Much of the research is focused on disaster response and not on disaster mitigation and prevention. The research on international aid driven programs is not much relevant to India as the programs in India are not international aid driven. The studies in the Indian context reveal that the programs undertaken in India also suffer from the setbacks discussed above. A white paper on CD, commissioned by the National Institute of Disaster Management, based on a nationwide study captures the limitations of the training interventions:

"Most of the training interventions being designed and implemented currently are not linked to an agreed larger capacity development vision and agenda: they are not based on clearly identified needs; are not in response to manifest demand from those for whom it is meant; and are largely supply driven. [SEEDS and Knowledge Links 2014]."

In India, increasing vulnerabilities and risk pose a major challenge for development. The current pandemic has exposed the lack of capacity not only in the developing countries but also the developed countries. It is necessary to ask what we should be prepared for, and is what the level of acceptance of risk is for which we should prepare. Our CD efforts should strike a balance between accepting the myth of preparedness [Aradau, 2010] and total preparedness for all catastrophes and black swan events.

3. INSTITUTIONAL MECHANISMS

3.1 Legal and Policy Framework

Capacity development should aim at strengthening disaster risk governance. The UNDRR defines disaster governance as "The system of institutions, mechanisms, policy and legal frameworks and other arrangements to guide, coordinate and oversee disaster risk reduction and related areas of policy" [UNDRR, 2016]. Thus, to develop national capacity, it is necessary to strengthen not only institutions and organizations, but also legal and policy frameworks, financing arrangements, local self-governments and urban local bodies, private sector participation, community engagement, research, partnerships, networks and other aspects of disaster governance.

The legal and policy framework in India is governed by the Disaster Management Act, 2005 (DM Act) and the National Policy on Disaster Management (NPDM) 2009. Though there are over a hundred laws related to management of events which may result in a disaster [NDMA, 2015], the DM Act, 2005, is the leading instrument that governs all disaster management related activities in the country including Institutional mechanisms, measures to be undertaken, CD and training, financing and audit, and offences and penalties.

According to the NPDM, "the primary responsibility for disaster management rests with the States. The institutional mechanism put in place at the Centre, State and District levels will help the States manage disasters in an effective manner" [NDMA, 2009]. As the institutional mechanisms at the national level play a supplementary and supportive role to help the state governments, the real capacity for DRR should vest with the state governments and district administration.

The DM Act needs to be revisited in the light of emerging risks, recent developments and trends in the field of DM. It is nearly 15 years since the DM Act was passed. There have been demands for improving the Act [Sarkar and Sharma, 2006; Chhotray, 2014; Nambiar, 2015]. Amendments for improvement should take into account also India's commitment to three International Frameworks (namely Sendai Framework, Sustainable Development Goals and Paris Agreement for Climate Change) and situations like the current pandemic. Despite the need for amendment, the existing DM Act provides ample scope for risk reduction, mitigation, improved response and CD.

3.2 Institutional Arrangements

The act envisages the National Disaster Management Authority (NDMA) as the apex body for DM, with the power to lay down policies and guidelines, to approve the national plan, to recommend funds for mitigation and to take other measures to manage, mitigate and respond to disasters. The following Institutions also have been set up as mandated in the DM Act: the National Institute of Disaster Management (NIDM) as the apex institute for training and CD; the National Disaster Response Force (NDRF) as specialist force for responding to disaster situations; and the State Disaster Management Authorities (SDMAs) and the District Disaster Management Authorities (DDMAs) as holographic miniatures of the National Authority with similar functions and powers at the state and district levels. In addition to the above, at the national level, central ministries and departments have been identified as the nodal ministries to deal with specific disasters. Though not mandated by the DM Act, 30 states have set up State Disaster Response Forces (SDRFs). The NIDM is vested with the responsibility of training, research, documentation and help building the capacity of training and research institutions. NDRF undertakes training programs on search and rescue for the SDRFs, civil defense and communities. Some states have set up State Institutes of Disaster Management but the rest conduct training through the State Administrative Training Institutes.

The DM Act emphasizes CD as an important responsibility of all the Disaster Management Authorities at the National, State and District levels. The NPDM prioritizes capacity building of the officials, functionaries, trainers and elected representatives. NPDM also spells out the need to build institutional capacity, training communities, training artisans and professionals. The act mandates that the Disaster Management Plans (DMP) at the national, state and district should include CD and the NDMP has focused on CD for all phases of the disaster management cycle. The PM's 10-Point Agenda for DRR insists on CD of local governments, women and knowledge networks. CD has been included as an important section in the template provided to central ministries/departments for their Disaster Management Plan and the District Disaster Management Plan. The guidelines issued by NDMA for the State Disaster Management Plan also include CD as an essential component of the plan.

3.3 Financing Mechanisms

The DM Act mandates allocation of funds for CD by all the Central Government and the Central Ministries and Departments and State Governments. Section 35 of the DM Act mandates the allocation of funds for capacity building. Central government in the revised list of items and norms of assistance from the State Disaster Response Fund and National Disaster Response Fund included two components for CD: A maximum of 10% of the annual allocation from SDRF for procurement of equipment for improving response and a maximum of 5% of the annual allocation from SDRF for CD. The activities which can be undertaken as part of CD have not been specified and hence it provides flexibility to the state governments to undertake activities as per the need and context of the state [MHA, 2015]. In the absence of any study regarding how the state governments have used these allocations, what activities were undertaken and the outcome, it is not possible to discuss how this financial allocation has led to CD in the state, district and community level.

The 15th Finance Commission has allotted 10% of the total financial allocation for the year 2020-21 for CD. This is meant to support SDMAs, State Institutes of Disaster Management, training and CD activities, purchase of emergency equipment and emergency response facilities. But, the stakeholders must make necessary budget provision over and above the SDRF allocations for CD activities envisaged in their plan.

4. ISSUES AND CHALLENGES

The NDMA, NIDM, NDRF, SDMAs and DDMAs were set up in addition to the existing mechanisms for a special focus on DRR. In the absence of objective studies, it is difficult to evaluate the performance of these authorities. There is also no comparative study of the disaster management organizations of different countries. CD that has taken place in the last decade is evidenced by the marked improvement in early warning capabilities, improved disaster response to hydro-meteorological disasters, particularly to cyclones, and reduction in Heat wave deaths. While the NDMA has prepared a comprehensive National DMP, the States have State DMPs. More than 650 districts have District DMPs in place.

The NDMA has been carrying out programs for government officials, officers of the Indian Administrative Service, parliament security staff, for health professionals, for teachers and other stakeholders. State level and district level multi-stakeholder exercises are also conducted by the NDMA. One of the flagship programs of the NDMA, the "Aapda Mitra Scheme" to create a cadre of volunteers across the country, has been a grand success as evidenced by the exemplary work of Apada Mitras during natural disasters and the current pandemic [NDMA 2020]. The NDMA jointly with the NDRF has conducted several regional joint exercises with SAARC nations, BIMSTEC countries, and IORA (Indian Ocean Rim Association Countries) for regional CD. The NIDM conducts numerous training programs targeting various stakeholders. The SDMAs and State Training Institutes have been focusing on training masons, health staff, CBOs/NGOs, elected members of Panchayati Raj, Engineers, district level officials, teachers and other employees in Government. The training courses cover a range of topics related to disaster management from general orientation and sensitization programs to mass causality management.

The SAARC interim Disaster Management Centre functioning in Gandhinagar, Gujarat, conducts training programs, workshops, seminars for SAARC nations. Besides maintaining a portal for knowledge sharing, it also implements a program for thunderstorm modeling for the member countries. Bulk of the programs in training institutes consists of short-term trainings focused mainly on individual skill development. Capacity for policy making, management, coordination and decision making also must be developed [Scott and Few, 2016]. Since high staff turnover in organizations, particularly in government, is a hurdle to sustainable CD [Scott and Few, 2016], CD programs "must address challenges of staff turnover, task of educating new recruits, keeping pace with technical challenges and incorporating the rapid advances in scientific knowledge" [NDMA, 2019a].

Research studies on the CD programs undertaken in India highlight several issues in the way such programs are carried out. A

White Paper commissioned by NIDM on CD and training in DRR for India captures the status of activities undertaken:

"The study reveals that while there is a robust institutional framework at the national and state levels for disaster management, required capacities to ensure effective DRR and CCA at the district and sub-district levels have yet to be developed. The biggest gap is in terms of community capacity and preparedness to deal with disasters, which was found to be largely missing across most of study states and districts. This calls for serious policy attention at the national level. An obvious lack of effort and coordination between state and non-state actors to plan and undertake joint DRR initiatives on the ground emerged as another major concern of the study [SEEDS and Knowledge Links, 2015]."

As rightly pointed out in the White Paper, despite legal provisions, institutional arrangements and a clear mandate for CD, there are many issues and challenges for sustainable CD. Setting up additional or extra-ordinary mechanisms does not automatically lead to improvement in DRR unless they are adequately empowered and capacitated [Thiruppugazh, 2014]. Setting up of an apex agency may result in learned helplessness or abdication of responsibility by the concerned ministries, departments or agencies. Though the SDMAs have been set up in all States and UTs, many states have not set up functional SDMAs and many which are functional are not efficient [Nambiar, 2015]. Many SDMAs are just committees without a secretariat to support their functioning. DDMAs do not have any secretariat or dedicated human resources though bulk of disaster management happens at the district level. There is a need to identify the capacity gaps in the institutions and address them as CD of other stakeholders depends on them.

While the national and state plans have been prepared, many of the ministries and departments are yet to prepare their plans. Unless Ministerial and State Plans are aligned with the national plan and activities for DRR and the roles of stakeholders are identified, the CD activities cannot be holistic and target oriented. For undertaking each activity mentioned in the plans, there is a need to analyze the capacity gaps and develop necessary capabilities for implementation.

Local-level CD is equally or perhaps more important than at other levels. But research has not focused much on enhancing local capacity for DRR [Tiwari, 2015; Zhang et al, 2015]. One of the seven targets of the SDFRR is to substantially increase the number of countries with national and local DRR strategies by 2030. The framework emphasizes empowering the local authorities with resources, incentives and decision-making responsibilities. Though mitigation is mostly the responsibility of the local authorities, such authorities suffer from capacity trap. Limited financial resources and exclusion from higher level policy making and decision-making affect their capabilities [Zhang et al, 2015]. In India, even big municipal corporations suffer from regulatory overload, lack of technical capacity and inadequate human resources, severely affecting the enforcement of regulations, DRR planning and implementation [Thiruppugazh, 2008].

There is a need to focus on the local fire and emergency response services and create a cadre of trained volunteers to improve response capacity at the local level. Local fire and emergency services, despite being the first responders in any disaster, suffer from many capacity constraints such as lack of human resources, equipment, infrastructure and training [NDMA 2019b]. Similar issues are faced by the SDRFs, civil defense volunteers and Home Guards. Trained and equipped volunteers can serve as first responders. Also, these volunteers can play role in informing and educating people going beyond search and rescue.

A systematic approach has to be adopted towards community-based DRR be by the state and non-state actors. It is not just the capacity of the planning and implementing agencies which count, but the capacity of the receiving communities also needs to be built to ensure sustainability. But, this aspect has not been paid adequate attention by the governments, donors and NGOs. Failure to involve people and build their capacity results in lack of knowledge and inadequate technology transfer resulting in short-lived success of DRR interventions [Thiruppugazh, 2010]. CD efforts in the aftermath of catastrophic disasters as part of the post-disaster reconstruction are not sustained and are not continued beyond the program and mainstreamed. Most of the programs fail as they attempt to replicate the projects and programs successful elsewhere, mostly as quick fixes ignoring the context. Majority of the programs are top-down, supply driven, replication of best practices, short-duration programs and quick fixes [Tiwari, 2015]. Building community capacity means building organizations, networks, leadership and build co-ordination mechanisms between governments and communities [Scott and Few, 2016]. Educational institutions and universities can play a major role in community CD, by undertaking research on the needs, demands and capacity gaps in communities, by providing technical solutions and conducting outreach activities.

Regional Mechanisms also can contribute to national CD. There has not been much research on the role of regional mechanisms in building national capacities [Ferris, 2014]. In addition to response-oriented joint exercises, joint research, hazard analysis and joint mitigation programs among the countries which share trans-boundary risks, exchange programs, and sharing of information are necessary.

Political aspects of CD are ignored often in research as well as in practice. A joint study [UNDP and IFRC, 2014] states: "construction of legal and institutional systems is not a technical issue but is a political process which needs to mobilize and reconcile the political interests of the stakeholders." The political capacity to "mediate conflict, respond to citizen demands, allow for the representation of interests, and provide opportunities for effective political participation at national, regional, and local levels is important" not only to "allow citizens and governments to deal with and resolve problems of everyday life" [Grindle, 1996] but also to manage disaster related problems.

The current COVID19 Pandemic has challenged not only the capacity of institutions that manage biological disasters, but also the physical infrastructure, equipment and other essentials for managing and curbing the spread of such disasters. The 'negative' effect is explicitly seen of capacity-development efforts that concentrate on training only a core group of healthcare personnel. As emphasized in literature [Tiwari, 2015], CD is not improving the way institutions manage disasters but also one of bringing about a change in the behavior of the people to prevent disasters.

5. CONCLUSION

Analyses of existing literature and current conditions indicate that there is need to shift the focus of CD initiatives from preparedness and response to mitigation and resilience. The legal framework should be updated to improve disaster governance to match the dynamic nature of risk and changing demands on the government. Though improvement of the legal framework is needed, the existing legal framework provides adequate authority to the concerned agencies for taking necessary steps for DRR. The imposition of lockdown throughout the country to manage the COVID 19 pandemic invoking the Disaster Management Act, 2005, is a case in point. But, more often it is lack of capacity rather than authority that leads to non-fulfillment of the legal mandates and effective implementation of DRR measures. While there is a need to build the capacity of the disaster management authorities all levels, a special focus is needed on the SDMAs and DDMAs which implement the programs and projects. The scope of CD should expand from imparting skills to the individuals to CD of the organizations and institutions. There is a need to go beyond organizing short-term training programs to sustainable financial, technical and managerial CD.

The local self-governments and urban local bodies responsible for planning, mitigation and enforcement of regulations themselves have no capacity for DRR activities. There is a need to look at the host of problems which plague these institutions and address them to ensure sustainable CD. Capacity development of the local self-governments and urban bodies should include training and education of the elected members. Community CD should aim at improving the understanding of risks, mitigation options, access to funds and government programs, networking with government and non-government actors and leadership development should be ensured to make the CD programs demand driven.

Capacity gap assessments should form the basis of design of CD programs and trainings. Gap assessments should be based on the worst-case scenario and the level of acceptable risk. The programs and projects for CD should go beyond trainings or one-time interventions but should be a continuous activity which builds on existing capacities to match the demand. Inclusive decision making will lead to ownership of the policies by the States and Districts and create an enabling atmosphere for CD.

Educational institutions and universities have to play a bigger role in CD, particularly in developing community capacity by undertake research on the capacity gaps and also take part in extension activities and in developing community leadership. Developing the capacity of the volunteers not only for response but also for community CD and pre-disaster preparedness will help to channel the untrained spontaneous volunteerism to contribute to DRR.

Successful DRR depends on successful CD, and its success, as the NDMP points out, will depend on participation and ownership of the stakeholders in such programs. Hence, national CD will depend on building the capacity of both the state and non-state actors.

References

1. Aradau,C., (2010), "The Myth of Preparedness," https://www.radicalphilosophy.com/commentary/the-myth-of-preparedness, accessed 28 September 2020
2. CaDRi, (n.d.), *Basics of Capacity Development for Disaster Risk Reduction*, CaDRi, Geneva, Switzerland
3. Chhotray,V., (2014), "Disaster Relief and the Indian State: Lessons for Citizenship," *Geoforum*, 54, 217-25
4. Guha-Sapir,D., Below,R., and Hoyois,P., (2016), "The CRED/OFDA International Disaster Database," https://public.emdat.be/data, accessed on 21 September 2020
5. Ferris,E., (2014), *Better Together: Regional Capacity Building for National Disaster Risk Management:* Brookings Institute
6. Fukuda-Paar,S., Lopes,C., and Malik,K., (2002), "Overview in *Capacity for Development: New Solutions to Old Problems,"* Editors Carlos Lopes, Sakiko Fukuda-Paar, and Khalid Malik, New York, Earthscan, and UNDP
7. GoI (Government of India). 2011. *Disaster Management in India* New Delhi: Ministry of Home Affairs, GOI

8. Germanwatch, (2019), "Global Climate Risk Index 2020: Who Suffers Most from Extreme Weather Events?"Weather-Related Loss Events in 2018 and 1999 to 2018, Germanwatche.V., Bonn, Germany

9. Grindle,S.M., (1996), *Challenging the State: Crisis and Innovation in Latin America and Africa*. Cambridge, United Kingdom: Cambridge University Press.

10. Hagelsteen,M., and Becker,P., (2013), "Challenging disparities in capacity development for disaster risk reduction," International Journal of Disaster Risk Reduction, 3, 4-13

11. MHA, 2015, *Revised List of Items & Norms of Assistance from State Disaster Response Fund (SDRF)/ National Disaster Response Fund (NDRF)*, Ministry of Home Affairs, New Delhi

12. Nambiar,M., (2015), "A Decade of Disaster Risk Management in India," Economic and Political Weekly, 50(5), 36-40

13. NDMA, (2009), *National Policy on Disaster Management*, NDMA, New Delhi

14. NDMA, (2015), *The Compendium of Laws on Disaster Management*, NDMA, New Delhi

15. NDMA, (2019a), *National Disaster Management Plan (NDMP))*, NDMA, New Delhi

16. NDMA, (2019b), *Fire Safety in India*, Proceedings of 15th Formation Day of NDMA, NDMA, New Delhi

17. NDMA, (2020), "Your Friends in Need," *Aapada Samvad*, 20, August

18. Sarkar,S., and Sarma,A., (2006), "Disaster Management Act, 2005: A Disaster in Waiting?" Economic and Political Weekly, 41(35), 3760-63

19. SEEDS and Knowledge Links, (2014), "*White Paper on Capacity Building and Training in DRR for India,"* National Institute of Disaster Management, New Delhi

20. Scott.,Z., and Few,R., (2016), "Strengthening Capacities for Disaster Risk Management: Insights from Existing Research and Practicem" International Journal of Disaster Risk Reduction, 20, 145-53

21. Venkatachalam,T., (2008), "Urban Vulnerability Reduction: Regulation and Beyond," *The Indian economy sixty years after independence,* Editor Raghbendra Jha, PALGRAVE MACMILLAN, London

22. Venkatachalam,T., (2010), "NGO Participation in Reconstruction: Knowledge Transfer and Capacity Building for Sustainability; a Case Study of Post-Disaster Reconstruction in Gujarat," *International i-Rec Conference: Participatory Design and Appropriate Technology for Disaster Reconstruction*, http://www.grif.umontreal.ca/pages/conferenceIREC2010papers.htm, accessed 28 September 2020

23. Venkatachalam,T., (2014), "Post-Disaster Reconstruction and Institutional Mechanisms for Risk Reduction: A Comparative Study of Three Disasters in India," *Disaster Recovery: Used or Missed Development Opportunity*, Editor Rajib Shaw, 17(40), Springer, Tokyo, Japan

24. Tiwari,A., (2015), *The Capacity Crisis in Disaster Risk Management: Why Disaster Management Capacity Remains Low in Developing Countries and What can be Done*, Springer, Switzerland

25. UNDP, (n.d.), *Supporting Capacity Development: The UNDP Approach*, UNDP, New York

26. UNDP and IFRC, (2014), *Effective law and regulation for disaster risk reduction: A multi-country report summary*

27. UNDRR, (2013), "Cyclone Evacuation to Become a Global Example," https://www.undrr.org/news/cyclone-evacuation-become-global-example, accessed 28 September 2020

28. UNDRR, (2015a), *Global Assessment Report on Disaster Risk Reduction*, United Nations, New York, USA

29. UNDRR, (2016), "Terminology," https://www.undrr.org/terminology/capacity, accessed 19 September 2020

30. UNISDR (2015b), *The Sendai Framework of Action*, UNISDR, Geneva, Switzerland

31. Zamfir,L., (2017), "Understanding Capacity-Building/Capacity Development: A Core Concept of Development Policy," https://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI(2017)599411#:~:text=While%20'capacity%2Dbuilding'%20suggests,change%2C%20borne%20by%20local%20actors, accessed 26 September 2020

32. Zhang,Q., Qibin,L.U., Hu,Y., and Lau,J., (2015), "What Constrained Disaster Management Capacity in the Township Level of China? Case studies of Wenchuan and Lushan earthquakes," *Natural Hazards*, 77, 1915-38

G. Padmanabhan

The Role of International Organisations in Disaster Management

Abstract: International organisations have been providing critical inputs to the Government of India through various development cooperation agreements towards reducing disaster risk and enhancing resilience. India's reliance on international agencies is not so much for funding but for implementing scalable innovative ideas that brings in transformative changes. Technical support provided is also to institutionalise capacity development initiatives within the context of sustainable development. Of late, support is tailored to help India achieve the priorities identified in global frameworks such as the Sendai Framework on Disaster Risk Reduction (SFDRR), Sustainable Development Goals (SDGs) and the Paris Agreement on Climate change (COP 21).

Key words: International Cooperation, Disaster Risk Reduction, Disaster Risk Management, Capacity Development, Sustainable Development, UN Agencies

1. INTRODUCTION

This paper on the role of International Organisations in Disaster Management (DM) in India is structured mainly under three categories - role of UN Agencies, role of Bilateral Organisations and the role of International Federations of Red Crescent Societies (IFRC). India does not seek international assistance for response but it welcomes support for strengthening preparedness and mitigation initiatives. In this context India has been maintaining a very cordial relationship with all these categories of organisations. Collaborative efforts are more for implementing scalable and replicable ideas/ models that provide innovative and transformative solutions to developmental challenges. Losses on account of disasters in India have been increasing as more and more high value assets are exposed to hazards and the climate change impacts are being felt regularly In addition, the vulnerabilities are mounting. What used to be once in 50+ years extreme event now seems to be occurring more often, in some cases even every year. India has also been collaborating with international organisations for ideas and good practices to attain progress on the priorities set under Global Agreements. The current such frameworks being used are the Sendai Framework on Disaster Risk Reduction (SFDRR), Sustainable Development Goals (SDGs) and the Paris Agreement on Climate change (COP 21) which together address Disaster Risk Reduction issues in the context of sustainable development and environment sensitivity.

2. UN ORGANISATIONS

UN's support to India is finalised in collaboration with the Government of India (GoI). There would be a broad UN framework, under which each of the UN Agencies, in consultation with their respective nodal Ministry at the Center, decided the thematic priorities. Thereafter, specific projects are formulated in consultation with the stakeholders. The UN agencies in India work under the leadership of the United Nations Resident Coordinator (UNRC). The UNRC represents the UN Secretary General and to the Government of that country, and is leader of the UN Country Team (UNCT). The UNCT consists of Heads of UN entities.

The UN in India works under the framework of the UN Development Assistance Framework. The latest such Framework agreed with the Government of India is called GoI-UN Sustainable Development Framework (SDF) 2018-2022. The SDF was formulated by the UN and NITI Ayog in collaboration with the line Ministries, and is harmonised with the Government's latest development vision "Sabka Saath Sabka Vikas" (Collective Effort, Inclusive Development) as well as the Global agenda "Leaving no one behind", also articulated in the 2030 Sustainable Development

Goals. In line with the priorities outlined in the SDF, the Agencies have formulated their respective Country Programme Documents.

Building on the lessons learnt from previous interventions supported by the UN Agencies, and in the context of the increasing widespread losses from disasters on account of greater exposure of assets to disasters, the SDF has foreseen specific interventions at all levels to enhance resilience of the communities and institutions, as well as to promote risk informed development. UNRC system has established Results Groups (RGs) for each of UNSDF themes to provide support for planning, implementation and monitoring of programmatic interventions.

In DM, there is yet another platform, the UN Disaster Management Team (UNDMT) to coordinate emergency activities of the UN Agencies. DMT gets activated whenever there is an emergency that would require UN intervention.

These two arrangements together ensure that there is no duplicity of efforts, ensure better coordination of planning and implementation to facilitate coherence and mutual reinforcement of the interventions.

2.1 Global Architecture of UN Agencies in the Field of disaster management:

Within the UN system, each Agency has the freedom to initiate programmes and allocate resources for various aspects of DM as per the agreed protocol that governs development cooperation. The UN Office for Coordination of Humanitarian Affairs (UNOCHA) has the mandate to establish appropriate framework within which each actor can contribute to the overall response effort. On the other hand, the UN Office for Disaster Risk Reduction (UNDRR) has the mandate to facilitate establishment of global frameworks and implementation of these for Disaster Risk Reduction. These two Agencies do not have field offices except OCHA, which has field offices in countries with unstable Governments or are in the process of establishing systems of Governance. However, they rely on country offices of other UN agencies to support implementation of activities in coordination with the Resident Coordinator's system.

2.2 UNOCHA

As India does not seek international assistance during the relief and response phases, OCHA has a limited role in India. However, India welcomes sharing of expertise and technical assistance based on international developments and good practices. In that spirit, India participates in OCHA mechanisms that support initial post disaster activities as follows:

(1) OCHA is the implementing agency of the United Nations Disaster Assessment and Coordination (UNDAC), a team of disaster management professionals that can be deployed at short notice to disaster affected country at the request of the Government or UNRC of that country. India became a member of UNDAC in 2001 and several officers have received UNDAC training. UNDAC team support national authorities and the UNDC to coordinate international relief on-site. (Disaster Management in India, Ministry of Home Affairs, GoI, 2011)

(2) Similarly, International Search and Rescue Advisory Group (INSARAG) is a UN global network of 80 countries and is a mechanism available with OCHA to deal with Urban Search and Rescue (USAR) related issues. India is a member of INSARAG Asia Pacific Regional Group, and instructors from India participate in the simulation exercises organised by the INSARAG. India was also the Chairman of INSARAG Asia Pacific Regional Group in 2005-06. INSARAG Asia-Pacific Earthquake Response Exercise was held in Agra, India from 3-6 May, 2011. (Disaster Management in India, Ministry of Home Affairs, GoI, 2011)

2.3 UNDRR

UNDRR, formerly known as UNISDR, was established in 1999 to ensure implementation of the International Strategy for Disaster Reduction. UNISDR's role is to provide necessary support for the implementation and review of the SFDRR (Sendai Framework for Disaster Risk Reduction 2015-2030). It also ensures coherence with other global commitments/frameworks such as Sustainable Development Goals (SDGs) and Paris Agreement on climate change.

It supports countries in its implementation, monitoring and sharing towards reducing existing risk and preventing the creation of new risk.

UNDRR has been collaborating with GoI on various aspects that facilitate formulation of global frameworks, its implementation and monitoring as well as sharing of good practices. Technical support from UNDRR has been forthcoming to develop capacities for monitoring and reporting progress on achievements under the global agreements. India also hosts collaborative events such as the Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR) in 2016 to exchange information on good practices in disaster risk reduction in the context of Sendai Framework for Disaster Risk Reduction (SFDRR) and to develop a monitoring framework. India is an active participant of all the regional and global consultations. Indian experts have been carrying out studies commissioned by UNDRR for various issues of Global Assessment Report on Disaster Risk Reduction [UNGAR, 2020] (GAR). It is the flagship report of the United Nations on worldwide efforts to reduce disaster risk. The GAR is published biennially by the UN Office for Disaster Risk Reduction (UNDRR), and is the product of the contributions of nations, public and private disaster risk-related science and research, amongst others.

2.4 UN Agencies that actively support Government in disaster management

Agencies that have been very active in the field of disaster management in India are: United Nations Development Programme (UNDP), United Nations Children's Emergency Fund (UNICEF), Food and Agriculture Organisation (FAO), United Nations Family Planning Agency (UNFPA), World Food Programme (WFP) and World Health Organisation (WHO). In addition to the above, other agencies, depending on the requirements, have been participating in various programmes. For example, in the past UNESCO and UNHCR had provided support in their respective areas of expertise.

2.4.1. UNDP

UNDP has been supporting the GoI to strengthen disaster management capacities in the country since 1995, initially in collaboration with the Ministry of Agriculture and later with Ministry of Home Affairs when the subject matter was transferred to this Ministry in 2002. The focus of support provided through various projects to the national and state governments is determined with an assessment of the requirements and Government priorities, which witnessed a paradigm shift from relief centric approach to a holistic approach of managing and reducing disaster risk. Over the last 'two and a half' decades, UNDP has played a significant role in capacity building for preparedness, response and mitigation, working very closely with the Ministry of Home Affairs (MoHA) and National Disaster Management Authority (NDMA) at the national level, and with the state governments and the communities in the hazard prone states in the country. The project that supported community capacity building during 2002-2009 has been rated as the Asia's largest community based DRM initiative. This project was implemented in 176 hazard prone districts in 17 states. The projects supported by UNDP since 1995 are:

1. 1995: Maharashtra Earthquake Rehabilitation Programme
2. 1996: National Capacity Building Project in Disaster Management
3. 1999: Orissa Cyclone - Community-based Disaster Preparedness Project
4. 2001: Gujarat Earthquake - Relief to Recovery - Local Capacity Building Project
5. 2002-2009: Disaster Risk Management Programme
6. 2004: UN Tsunami Recovery Framework
7. 2008-2012-Disaster Risk Reduction Programme
8. 2009-2010: Regional Climate Risk Reduction Project in the Himalayas
9. 2009-2011: Kosi Flood Recovery and Reconstruction Project
10. 2011-2013: Climate Change Adaptation and Disaster Risk Management Project

11. 2013-2017: Enhancing Resilience of Institutions and Communities for Disasters and Climate Change
12. 2016-2020: Developing Resilience of Cities through Risk Reduction to Disasters and Climate Change.

Summary of these projects are available on the website of the Ministry of Home Affairs, GoI [MHA, 2020].

Table 1: Documents developed under GOI-UNDP Projects [MHA, 2020]

S. No.	Document	Year
1	Mainstreaming Disaster Risk Reduction & Climate Change Adaptation in the National Flagship Programmes	2019
2	Mainstreaming Disaster Risk Reduction & Climate Change Adaptation in District Level Planning	2017
3	Training needs Assessment of Tripura state	2017
4	Multi-Hazard Risk and Vulnerability Assessment (HRVA) for City of Cuttack, Odisha	2017
5	Action Plan for Mainstreaming Disaster Risk Reduction and Climate Change Adaptation	2016
6	Disaster Risk Reduction: A Handbook for Urban Managers	2016
7	Comprehensive Capacity Building Program on Basic Disaster Management for Civil Defence/ Home Guards/NYKS/Red Cross/NCC and NSS Volunteers by Himachal Pradesh	2016
8	Comprehensive Disaster Management Course for District Disaster Management Authority including Municipal Officials by Himachal Pradesh	2016

9	Training needs assessment on disaster risk reduction and climate change adaption	2014
10	Hazard Risk and Vulnerability Analysis (HRVA) of the City of Bhubaneshwar, Odisha	2014
11	Water Resources Management for Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR)	2013
12	Assessment of DRM effectiveness responding to very severe cyclonic storm "Phailin" in Odisha	2013
13	Sikkim Multi-Hazard Risk Vulnerability Assessment	2012
14	Navi Mumbai Municipal Corporation- Fire Hazards Response and Mitigation Plan	2010
15	Review Of Early Warning System in Bhubaneshwar, Gangtok, Madurai, Navi Mumbai, Shimla, Thiruvananthapuram And Visakhapatnam	2013
16	Review of Early Warning System Bhubaneshwar	2013
17	Review of Early Warning System Gangtok	2013
18	Review of Early Warning System Madurai	2013
19	Review of Early Warning System Navi Mumbai	2013
20	Review of Early Warning System Shimla	2013
21	Review of Early Warning System Thiruvananthapuram	2013
22	Review of Early Warning System Visakhapatnam	2013
23	A Study on Mainstreaming DRR and CCA in Development Planning, Volumes I, II and III	2013

2.4.2 UNICEF

While the nodal Ministry for UNICEF is the Ministry of Women and Child Development, on matters related to Disaster Management it work in collaboration with the NDMA. UNICEF's Country Program 2018-2022 has disaster-risk reduction, climate change and social cohesion as priorities to be addressed over the five years. Specifically, it focusses on strengthening the capacities of state disaster management systems and community capacity building required for disaster risk reduction. Also, it integrates risk reduction strategies into the education, health, nutrition and water and sanitation sectors to build resilience. UNICEF also supports the design of comprehensive school safety programs to reduce the risks faced by children in schools. UNICEF along with other UN agencies such as UNDP and UNFPA provided technical inputs for the design and finalising implementation arrangements of the National School Safety Program, supported by NDMA [NSSP, 2011]. The "National School Safety Program (NSSP)-A Demonstration Project", approved by Government of India in June, 2011 with a total cost outlay of Rs.48.47 Crore was implemented by National Disaster Management Authority (NDMA) in collaboration with the Ministry of Human Resource Development (MHRD) and in partnership with the State/ UT Governments. NSSP was a holistic project to promote the culture of Safety in Schools and is covering 200 schools in each of the selected 43 districts spread over 22 States/UTs of the country falling in seismic zone IV & V.

The emphasis is on strengthening the capacities of state disaster risk management governance systems and institutions at all levels, and supporting them to implement child-centred, risk informed programming plans and strategies. UNICEF also focuses on Community based disaster risk management program involving children and adolescents that support resilience initiatives in urban and rural settings. UNICEF undertakes risk-informed programming to strengthen systems that support children and their families to anticipate, withstand and quickly recover from shocks. Yet another stream is to support government in mainstreaming child-centred disaster risk reduction. Efforts are made to improve the resilience of rural and urban communities to disaster, and to build communities'capacity to meet challenges of climate change for the protection of children's rights.

During emergencies and humanitarian contexts, UNICEF works in collaboration with NGOs to facilitate emergency preparedness and response mechanisms that enable an effective emergency response to humanitarian crisis.

2.4.3. UNFPA

UNFPA's Country Program 2018-2022 has three major outcome areas [UNFPA, 2018], namely: (i) Sexual and reproductive health, (ii) Adolescents and youth, and (iii) Population dynamics. Through these focus areas the intent is to provide programatic support to enhance the capacities of the health system at the national level and in selected states. It will provide high-quality reproductive health and family planning services, with a focus on young women and adolescent girls as well as advocate for integration of sexual and reproductive health, including the minimum initial service package, within humanitarian response and disaster risk reduction policies and programs at national level and in selected states. UNFPA will also generate evidence, provide policy briefs and build networks to promote a better understanding of linkages between population dynamics and the achievement of the Sustainable Development Goals on ageing, urbanisation, young people and gender-based violence to inform national and state policies and programs.

To address sexual reproductive health needs in the aftermath of a disaster, the NDMA and UNFPA have developed a service package to help prioritise these issues. The Minimum Initial Service Package (MISP) for Sexual Reproductive Health in Disasters in India is a manual intended to help humanitarian workers address these and other issues and young people's specific needs in disaster preparedness and response. The aim is to ensure that districts and states throughout India have the Minimum Initial Service Package integrated in every health plan, in every disaster management plan and in every department's plan document and budget.

UNFPA, in collaboration with NDMA, National Health

Missions SPHERE-India and state Governments, had conducted series of capacity building sessions specifically focussing on MISP. During emergencies MISP kits were also distributed to some of the states at the request of NDMA.

2.4.4. WHO

The WHO India Country Cooperation Strategy (CCS) 2019–2023: A Time of Transition was developed by the Ministry of Health and Family Welfare (MoH&FW) of the GoI and the WHO Country Office for India. It outlines how WHO can support the MoHFW and other Ministries to drive impact at the country level. The CCS builds on other key strategic policy documents such as the National Health Policy 2017, the many path breaking initiatives India has introduced — from Ayushman Bharat to its National Viral Hepatitis Control Program and promotion of digital health amongst others. The period of this CCS is expected to bring rapid and significant changes to India's health sector and to improve access to quality health care, especially to the vulnerable and underserved populations.

WHO's technical support to the GoI is under the following four strategic priorities:

1. Accelerate progress on Universal Health Coverage (UHC) by supporting implementation of Ayushman Bharat: Health and Wellness Centres and hospital insurance scheme; improving access to priority health services, such as immunisations, maternal and child health, tuberculosis, hepatitis, eliminating neglected tropical diseases and control of vaccine-preventable and vector-borne diseases.
2. Promote health and wellness by addressing Environmental health, including air pollution concerns; mental health promotion and suicide prevention; nutrition and food safety; and road safety
3. Protect the population against health emergencies by strengthening disease surveillance and outbreak detection and response, roll-out of integrated disease surveillance program using the real-time Integrated Health Information Platform (IHIP), preparedness for, and response to all emergencies.

4. Enhance India's global leadership in health by improving access to medical products of assured quality made in India; and by strengthening India's leadership in digital health.

The WHO Country Office for India (WCO India) has been working closely with the GoI to step-up preparedness and response measures for COVID-19. The range of support being provided include surveillance and contact tracing, laboratory testing, risk communications and community engagement, hospital preparedness, infection prevention and control, and implementation of containment plan at all three levels of the health system – national, state and district. The entire field staff of WHO consisting of more than 2000 personnel, has been fully re-purposed to support the government to overcome this challenge [CV, 2020].

At the national level, WHO is providing technical support to the Ministry of Health & Family Welfare (MoHFW) and works closely with National Centre for Disease Control (NCDC), Indian Council of Medical Research (ICMR), National Disaster Management Authority and NITI Aayog.

2.4.5 WFP

WFP and UNDP are jointly implementing a project on "India's Response to COVID-19: Inclusive and scalable social protection system for immediate and sustained food, nutrition and livelihood security". The purpose is to support the newly vulnerable to access food and livelihoods and strengthen the outreach of government safety nets to ensure the right to food and to paid work. Some of the activities supported by WFP [WFP, 2020] are:

1. Development of a mobile application called Jan Aapurti to connect 12 million people to registered retailers in Uttarakhand to provide access to doorstep delivery of essential commodities during the lockdown. The app also provides information on accessing government entitlements and on preventing the spread of COVID-19.

2. Development of a price monitoring dashboard for 22 essential commodities across India. Using regularly reported government data, the dashboard covers 140 locations and indicates daily price increase.

3. WFP is conducting sessions on supporting food security and nutrition during the COVID-19 pandemic for the Sphere India COVID-19 Academy, which is a joint initiative of UNICEF, the World Health Organization (WHO), HCL Foundation and Sphere India. This session aimed to strengthen the capacity of frontline workers of civil society organisations.
4. WFP developed standard operating procedures on food safety and hygiene, targeting the kitchen staff of community kitchens that are feeding vulnerable people. This was then disseminated to more than 2,000 frontline NGOs and civil society organisations for the national COVID-19 response.

Apart from the above main agencies providing support to Government on disaster management activities in India, there are other UN agencies that provide technical support on a case to case basis. The UN High Commission for Refugees (UNHCR) had in the past organised series of training programmes in collaboration with the National Institute of Disaster Management (NIDM) to strengthen the capacities of concerned state officers on camp management. The Food and Agriculture Organisation has been very active along with other UN agencies in providing technical support for drought management in the country.

3. BILATERAL AGENCIES

3.1 United States Agency for International Development (USAID)

USAID has been providing technical support to the GoI to strengthen disaster management systems in the country. Notable initiatives are [NDM, 2020]:

1. Program for Enhancement of Emergency Response (PEER): Through its Office for Foreign Disaster Assistance (OFDA), USAID has been supporting a regional training initiative known as PEER to strengthen disaster response capacities in Asia. India is one of the eight countries that participated in the programme. The focus has been on:

1. Community Action for Disaster Response (CADRE)
2. Hospital Preparedness for Emergencies (HOPE)
3. Medical First Responder (MFR) and Collapsed Structure Search and Rescue (CSSR)

1. Disaster Management Support (DMS) Project: During the period April 2007 to March, 2015 USAID supported the DMS project with the following scope:
   1. Incident Response System (IRS),
   2. Procurement of equipment
   3. Capacity building

The Incident Command System (ICS) was introduced, and capacity built to roll it out in states for which a Centre at Lal Bahadur Shashtri National Academy of Administration (LBSNAA) and Regional Training Centres in some of the states were developed under this project. Subsequently, NDMA issued guidelines on Incident Response System, a modified ICS suited for Indian administrative system [NDMA, 2020]. A comprehensive disaster management curriculum for Civil Defense cadre and a Disaster Communication for Public Information Officers were also developed under this project. In addition, equipment for Advance Search & Rescue (ASAR) were procured and supplied to the National Industrial Security Academy, Hyderabad. Under the project various climate modelling for local areas, including analysing risk of sea level rise in coastal cities as well as training activities were carried out.

3.2. Government of Switzerland

India signed an agreement with Government of Switzerland in 2003 based on the assistance given by them after the Gujarat Earthquake. The agreement, among other things, focussed on enhancement of capacity building, preparedness and training of rescue teams, training programme in Canine Search and Urban Search & Rescue, develop capacity and development of infrastructure for International Search and Rescue Advisory Group (INSARAG) standards and capacities.

3.3. Government of Russia

Considering the advanced emergency management systems in Russia, the GoI had entered into bilateral agreement with Government of Russia in 2010 to strengthen monitoring and forecasting emergencies and assessment of its consequences, assessment of risks for environmental emergencies due to pollution caused by an emergency; exchange of expertise and experiences in emergency management; etc.

3.4 Others

Other governments such as the Norwegian Government and the Australian Government have also provided technical support in specific areas of disaster management in the past. Indo-Russian, Indo-Swiss and USAID agreements are bilateral. In the case of some agencies such as USAID, DFID, Government of Japan, tripartite arrangements involving UN was allowed with the approval of the Ministry of Home Affairs, the nodal Ministry at the Centre for coordinating disaster management activities.

Regional platforms such as the ASEAN Region Forum (ARF), Asian Disaster Reduction Centre (ADRC) and SAARC Disaster Management Centre (SDMC) have also helped in exchanging knowledge through organisation of joint Conferences and Workshops on various topics by bringing either countries in the region to discuss and agree on partnership initiatives.

Most of the technical support provided under these agreements focussed on strengthening response systems in the country. With the advent of global conferences highlighting the importance of risk reduction, and following Government's paradigm shift in its approach to disaster management in the country, the focus of the support has also become holistic. After the adoption of Sendai Framework for Disaster Risk Reduction (SFDRR), all the bilateral and multi lateral agencies are providing support to SFDRR priorities.

4. INTERNATIONAL FEDERATION OF RED CROSS AND RED CRESCENT SOCIETIES (IFRC)

The International Federation of Red Cross and Red Crescent

Societies (IFRC) is the world's largest humanitarian organisation which carries out relief operations to assist victims of disasters. It also provides support to strengthen the capacities of its member National Societies. The IFRC's work focuses on four core areas: promoting humanitarian values, disaster response, disaster preparedness, and health and community care. In India, IFRC provides support through the Indian Red Cross.

In India, the national society for IFRC is the Indian Red Cross. The Red Cross runs a Social and Emergency Response Volunteer (SERV) Program to build community resilience through training of the target group by Master Trainers, Instructors and SERV volunteer across states. The attempt is to provide on an average, 1000 trained SERV volunteers and 2 trained SERV instructors in each district. These SERV volunteers will also impart health and disaster related messages in addition to leading social campaigns in the community.

On Disaster Preparedness, Red Cross initiated a nation-wide Community Based Disaster Preparedness (CBDP) training programme in 1999. Subsequently a strategic plan for disaster preparedness and disaster response (2004-2007) was formulated. The program envisaged institutional strengthening, training and knowledge sharing, programs for strengthening CBDP in disaster prone areas.

5. SUMMARY

The allocation of resources for DRR activities in the country has seen a quantum jump in the recent years. Compared to the domestic allocation of resources, funding from external agencies may not be much but they do bring in the critical technical inputs which benefit the government's investment in risk reduction. The very nature of engagement, finalised based on consultations with the concerned Ministries and Department of Economic Affairs (GOI), ensures that the technical support provided are as per the emerging requirement in the country.

Multilateral agencies such as UNDP and UNICEF have played a critical role in introducing path breaking interventions that have over a period of time become a part of the governments' routine programs. One such intervention is the support to state governments on community preparedness. During cyclone Phailin in 2013, Odisha State could save several lives, compared to lives lost during a similar intensity Cyclone (super cyclone) in 1999, because of the good preparedness capacities sustained with state Government's support even after the UNDP support ended. The model of providing professionals to the district authorities under the DRM program had its impact. Now NDMA has a program through which support is being provided to the States to engage district disaster management officers. External support from international agencies should be for a limited period with clear cut exit strategy to sustain the capacities built.

References

1. CV, (2020), Preparedness and Response Measures for COVID-19, India

   https://www.who.int/india/emergencies/coronavirus-disease-(covid-19)

   Accessed on 26 September 2020

2. MHA 1, (2020), Website of *Ministry of Home Affairs*

   https://www.ndmindia.nic.in/documents

   Accessed on 25 September 2020

3. MHA 2, (2020), Website of the Ministry of Home Affairs, Government of India

   https://www.ndmindia.nic.in/goi-undp-projects

   Accessed on 01 December 2020

4. NDM, (2020), *Disaster Management in India*, Ministry of Home Affair, Government of India

   https://www.ndmindia.nic.in/images/pdf/disaster_management_in_india.pdf

   Accessed on 01 December 2020

5. NDMA, (2020), Incident Response System, National Disaster Management Authority, Government of India,

   https://ndma.gov.in/sites/default/files/PDF/Guidelines/incidentresponsesystemjuly.pdf

6. Accessed on 01 December 2020

7. NSSP, (2011), *National School Safety Program - a demonstration project*, Government of India

   https://ndma.gov.in/en/national-school-safety-programme-a-demonstrative-project

   Accessed on 25 September 2020

8. UNFPA, (2018), UNFPA's Country Program 2018-2022, Government of India

   https://www.unfpa.org/sites/default/files/portal-document/N1724035.pdf

   Accessed on 01 December 2020

9. UNGAR, (2020), *UN Global Assessment Report on Disaster Risk Reduction*, *https://gar.undrr.org*

   Accessed on 29 September 2020

10. WFP, (2020), Website of WFP

    https://reliefweb.int/report/india/wfp-india-country-brief-april-2020

    Accessed on 26 September 01 December 2020

Ravi Sinha

Projecting Risk Scenario for Disaster Risk Management

Abstract: The world is experiencing increasing threat to human lives and well-being on account of disasters. The data during last few decades shows that, while the number of people affected by disasters as a proportion of global population is decreasing every decade, the number of casualties and economic losses are both increasing. During the last three decades, several important developments have taken place to improve the management of disaster risks. There is global understanding that disasters threaten well-being of society and are an impediment to sustainable development goals. This paper discusses the evolution of disaster risk reduction to its current status from the perspective of governance and the role of governments. The paper also describes an important concept, that of disaster risk scenario, that has been recognised as an integral part of contemporary risk reduction practice. The paper also provides an example of use of disaster risk scenario in Indian context and demonstrates the range of critical information that it can provide, which is not available from traditional knowledge and experience from past disasters. The paper shows that risk scenario provides actionable information for prioritisation of disaster management efforts and can act as a decision-support tool for the government and other stakeholders.

Key words: Disaster Scenario, Risk Management Plans, Human Casualties, Economic Losses, Cost-benefit Assessment

1. INTRODUCTION

A large number of disasters occur around the world every year. As per the Centre for Research on the Epidemiology of Disasters database, over 8,000 natural disasters occurred between the years 2000-2020 [CRED, 2020]. A study on effect of natural disasters reports that during 1994-2014, over 1.35 million lives were lost due to natural disasters [CRED, 2015]. Also, the study reports that while similar numbers of natural disasters occurred in both developing and developed countries during this period, the casualties were disproportionately concentrated in developing countries. The developed countries accounted for around one-third of the deaths with the remaining occurring in developing countries. During the same period, it was observed that the number of people affected by natural disasters has decreased from 1 in 23 between 1994 and 2003 to 1 in 39 between 2004 and 2013. The decrease is partly due to the increase in global population. But, the decrease in also attributed to improvement in disaster risk management and illustrates the positive effect of disaster risk mitigation and prevention initiatives in various countries. Unfortunately, the trend of death rates due to natural disasters shows a continuous increase. Between 2004 and 2013, an average of nearly 100,000 deaths occurred due to natural disasters every year [CRED, 2015]. Another study by the Centre for Research on the Epidemiology of Disasters shows that the economic losses due to disasters are also increasing over the years [CRED, 2018]. This trend has been also brought out by the World Bank, which has estimated that economic losses due to natural disasters has increased from around $23 billion a year in the 1980s to $150 billion a year during the last decade [World Bank, 2020].

Management of disasters is an integral governance activity. Managing the adverse consequences of a major disaster has been always considered as an important responsibility of the government. Traditionally, the governments provided succour to the affected people by undertaking rescue of the affected people, providing short-term and longer-term relief, facilitating their rehabilitation, *etc*. Traditionally, most of these activities were exclusively carried by government entities. During the last few decades, particularly from 1950s onwards, the efforts of the governments have been supplemented by humanitarian organisations such as international non-governmental organisations, local non-governmental organisations and volunteer organisations. While the governments carry out a whole range of activities after a disaster, these organisations supplement in narrowly defined roles such as sharing the burden of providing relief, assisting in providing rehabilitation, *etc*.

The traditional post-disaster efforts, while very beneficial for the affected region, typically did not contribute to reducing the risk of similar or greater losses if similar events were to occur in future affecting the same people, and thus did not reduce the underlying risk. The approach of the government was also one of considering disaster management as a one-off activity, where the government's human and capital resources are re-deployed for a short while for disaster management from routine governance activities. In the traditional approach, therefore, the governments considered disasters as extraordinary events requiring short-term special attention with the primary objective to provide succour to the affected people. The human and capital resources of the government would be subsequently redeployed for routine activities. This approach thus did not typically focus on strengthening the governance to reduce the severity of disasters in future.

This paper discusses the emergence of disaster management as a distinct and mainstream activity of the governments during the last few decades. The paper also discusses the paradigm shift in focus from management of response after an event to disaster management, and further to disaster management, and finally to disaster risk reduction. The emergence of disaster scenarios as a tool during this transition, and its important role is also discussed. The paper further describes the methodologies for development of risk scenarios and risk communication. Finally, the paper discusses the future trends and the opportunities for integration of disaster scenario with the requirements for mainstreaming of disaster risk management in governance as well as in the activities of other stakeholders.

2. EVOLUTION OF DISASTER MANAGEMENT PARADIGMS

The United Nations Office of Disaster Risk Reduction defines Disaster Risk Management as the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses [UNDRR, 2020]. Disaster risk management plans set out the goals and specific objectives for reducing disaster risks together with related actions to accomplish these objectives. Disaster risk management, or more broadly disaster risk reduction has been recognised as a distinct activity requiring specialist knowledge only during the last few decades. The formal beginning of formal disaster management as a specialist responsibility began from 1990, when the United Nations observed the International Decade for Natural Disaster Reduction (IDNDR) during 1990-1999. For the first time ever, the nations recognised that disaster management was a non-routine governance activity requiring multi-organizational involvement and specialist knowledge. Both, the recognition of disaster management as a distinct governance activity, and the involvement of multiple stakeholders, were novel and indicated a shift from the typical practice of limiting short-term role of governments to managing rescue, relief and rehabilitation after a disaster. During this decade, there was also recognition that disasters can be caused due to a combination of underlying hazard as well as the vulnerability of the elements that are exposed to the hazard. The decade also recognized that a sizable proportion of the exposed elements are created through human activities. The IDNDR therefore also advocated integrating the principles of disaster management into developmental plans so that the creation of highly vulnerable elements in regions of high hazard can be avoided.

During the IDNDR period, the Yokohama Strategy and Plan of Action for a Safer World [UN, 1994] was enacted. It encouraged mainstreaming of disaster management with focus on prevention, mitigation, preparedness and relief. Among other novel suggestions for that time, the Yokohama Strategy encouraged improving understanding of the risk through scientific developments. In India, the High Powered Committee on Disaster Management, set up in 1999, recommended paradigm shift towards preparedness and risk management [NCDM, 2001]. The approach recommended by the

High Powered Committee encouraged use of scientific knowledge in addition to traditional knowledge and experience to assess risks and identify the most appropriate disaster management strategies.

Often, it is felt by governments that, due to the occurrence of a large number of disasters every year, the experience of managing them over the decades can provide sufficient information regarding the various facets of successful disaster risk management. It is assumed that traditional knowledge and experience from past disasters are sufficient to identify their causes and determine the suitable measures that are required to manage similar disasters in future. But, it is now recognized that traditional knowledge or experience from past disasters, while extremely valuable for disaster risk management, are not sufficient. The consequences of a disaster and the details of its management are rarely captured in a comprehensive manner so that it can be integrated as a part of decision support system in future. It is also found that the high impact disasters, such as a large earthquake or a severe cyclonic storm, occur after long intervals of decades or even centuries, and memory of past occurrences among the government as well as other stakeholders rapidly diminishes over time. As a result, the government and the people are generally not equipped to utilise their past experience to reduce losses during recurrence of a similar event in future. The recognition of this lacuna in available information based on traditional knowledge and past experience has led to the quest for other sources of information to supplement the available knowledge. It is now recognised that scientific knowledge can be very importance to supplement the traditional knowledge and experience to provide the additional information to formulate effective disaster risk management plans. It is recognised that the necessity of scientific knowledge of a potential disaster becomes even more important in case of hazards that occur after long intervals, such as tsunami, volcano eruption, etc. where traditional knowledge among the people regarding the disaster may have dissipated over time.

Subsequent to the Yokohama Strategy, the United Nations approved the Hyogo Framework for Action 2005-2015 [UNISDR, 2015]. The Hyogo Framework advocated understanding the risk, including all contributing components and various dimensions of consequences of the risk, as a primary objective of disaster risk management. It further advocated that risk management should be based on understanding not just the consequences of the disaster, but also the consequences of various interventions that can be taken to prevent, mitigate, manage or respond to a disaster. This change from the approach based on traditional knowledge and experienced implicitly recognized that tremendous scientific advancements in the understanding of underlying hazards, in the estimation of impact of the hazard on the built environment and community, and in the assessment of the consequences of the disaster and various interventions would also enable the modelling and analysis of large-scale potential events, which was not possible in the earlier decades. The Hyogo Framework for Action also took into account the importance of reliable data for carrying out realistic scientific assessments. The need to capture reliable information relevant to disaster risk management was also highlighted in the Hyogo Framework for Action, so that scientific modelling can improve over time with the availability of better data and more comprehensive modelling tools.

Depending on the modelling, data, and user requirements, a variety of disaster scenarios can be developed to tailor to the need of the end users. For example, scenarios can be developed to predict the consequences of different intensities or magnitude of a hazardous event. The scenarios can similarly simulate the resulting differences in consequences due to the implementation of various short-term and long-term policies and programs. For example, disaster simulations of tropical cyclones can be developed for vulnerable areas considering different severity of the storm. Scenarios can be also developed that consider differing resistance of the building stock to cyclonic storm depending on their extent of compliance with building codes. Also, scenarios can consider the likely consequences of different extent of evacuation of people to cyclone shelters, resulting requirements of food and basic necessities, time taken for normal economic activities to resume, etc. Often, the scenarios permit tracing of underlying causes for particular outcomes, and they are thus helpful to understand the factors that can increase or reduce vulnerability due to the disaster. The sensitivity of these factors can also be simulated and provide a basis for cost-benefit assessment of various possible actions.

The importance of using risk scenarios for disaster risk management has been further emphasised through the adoption of Sendai Framework for Disaster Risk Reduction 2015-2030 by the United Nations [UNDRR, 2015]. The Sendai Framework, that succeeded the Hyogo Framework for Action has outlined seven targets and has underlined four priorities for action to prevent new and reduce existing disaster risks. The very first priority for action is to understand disaster risks, underlining the importance of science-based and knowledge-driven risk reduction policies. This priority for action also illustrates the transition of disaster scenarios from supporting the decision-making process as recommended in Hyogo Framework for Action, to become its central core. The Sendai Framework recommends that "Policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. Such knowledge can be leveraged for the purpose of pre-disaster risk assessment, for prevention and mitigation and for the development and implementation of appropriate preparedness and effective response to disasters." The Sendai Framework further recommends the requirements at global, regional, national and local levels.

The use of disaster risk scenarios is now not only mainstreamed, but also is recommended as central to disaster risk reduction programs. This has been facilitated by the advancements in scientific understanding of the contributors to disaster risks, and modelling techniques for scenario developments. These advancements have greatly improved their accuracy and are able to provide sufficient information to consider various cost-benefit factors. The increase in use of risk scenarios for disaster risk management during the last decade, particularly in developed economies, and its obvious benefits to the stakeholders also has facilitated the mainstreaming of risk scenarios.

3. DISASTER RISKS

Disasters are typically considered to be a consequence of: (1) the occurrence of a hazardous event, (2) the vulnerability of the infrastructure and built environment due to the hazardous event, and (3) the exposure of people, economic activities, governance system, etc., to the vulnerable infrastructure and built environment. This juxtaposition can be shown in a pseudo-form as:

Disaster Risk = Hazard × Vulnerability × Exposure

The hazardous event may have a particular size and location, such as in the case of an earthquake or a nuclear event, or may be geographically and temporally dispersed as in the case of an epidemic. The hazard is defined as natural hazard, such as an earthquake or a cyclonic storm, or man-made hazard such as a nuclear accident. Hazards may occur without warning, such as in the case of an earthquake, or may occur only after adequate forewarning as in the case of a cyclonic storm. This criterion also classifies hazards as rapid onset hazard, where no or very limited warning can be provided before the event, and slow onset hazard where warning can be provided with long lead period.

For example, in the case of earthquake risk at a place, the earthquake hazard may be specified in terms of its potential magnitude, its location estimate such as its epicentre and depth, and the projected time of occurrence. The associated seismic fault and its properties may also be specified. The parameters that are required to estimate the propagation of earthquake ground shaking, such as ground motion prediction models and soil properties of the region, may also be specified. The earthquake hazard can be estimated by using the above, and can be specified in terms of strength of ground shaking (such as peak ground acceleration) at different locations that are likely to be affected by the earthquake.

The severity of the hazard influences the extent of disaster. But, a hazard, by its mere occurrence, does not become a disaster. Its affect needs to be sufficiently widespread, and it should occur with sufficient ferocity to be beyond the capacity of the communities to absorb or manage the consequences under normally occurring circumstances. This aspect is addressed under vulnerability.

The vulnerability is considered in terms of the elements at risk that are exposed to the hazardous events. The elements may include built environment such as buildings and infrastructure facilities. Also, vulnerability incorporates the extent of use of the exposed elements based on their location and the time of occurrence of the hazard, *etc*. For example, in case of earthquake risk, vulnerability considers the types of buildings and infrastructure in the region of earthquake shaking and their inherent strength against ground shaking due to the size of the earthquake event. Further, vulnerability considers the use of the buildings and elements, and assesses the likely loss of functionality due to the earthquake. Two identical buildings, one being used for a hospital and the other for office use, for example, may suffer similar damage due to an earthquake but their extent of loss of functionality and its consequences may be very different. The vulnerability thus takes into account both the physical damage and the functional disruption.

Exposure considers the consequence of the occurrence of the hazard and its effect on the exposed elements at risk. The exposure may be specified in terms of number of people who are affected by the event, number of casualties due to the adverse consequences, such as damage to buildings. These are typically classified as social losses. The consequences may be also specified in terms of financial losses. The financial losses may be attributed to direct loss such as loss of property value due to building and infrastructure damage. The indirect financial losses may be due to loss of productivity caused by damage to the built facilities, injury to people, disruption to supply chains, *etc*. Often, the human casualties also are considered in addition to other social losses.

Exposure can also represent information regarding the resilience or coping capacity of the affected region. For example, the inherent strength of the buildings and other infrastructure can be higher if the construction standards are high or their compliance is better. Resilient economic activities would imply that the occurrence of the hazard would cause lesser disruption compared to situations of low resilience. Resilience can also factor quality of social infrastructure. For example, a region with good emergency medical care system would have lesser proportion of the injured people succumbing compared to another region with deficient medical care system.

All three components of disaster risk, namely hazard, vulnerability and exposure, can be modelled to develop disaster scenarios. The available scientific knowledge for different hazards is not the same. For some hazards such as cyclonic storms, the hazard associated with a hypothetical location of landfall can be accurately modelled. But, for most hazards, the scientific information has varying degree of uncertainty and the accuracy of the model may not be as high. The modelling of vulnerability and exposure, including all components that contribute to these factors are also feasible. Also, scientific understanding of hazard, vulnerability and exposure all areas of active research and development. The scientific advancements in these fields are constantly improving the ability to model these events and predict the resulting scenarios.

4. THE DISASTER RISK REDUCTION CYCLE

Disaster Risk Reduction is commonly understood to consist of a number of distinct but overlapping activities. These activities include the ones that are to be taken with specific context of a disastrous situation, or are developmental activities that are to consider disaster risk as one of the parameters. For example, the former activities may include better enforcement of construction standards so that the buildings are stronger. The latter activities may include keeping critical hospitals well equipped to scale operations and handle much larger number of patients at very short notice.

Typically, disaster risk reduction activities are represented as a cycle, with the starting point as a disaster, and ending with the next disaster. This system of illustrating disaster risk reduction helps to emphasise that disasters are recurrent events even if the specific hazards are different or occur after long intervals. The cyclic representation of disaster risk reduction also helps to underscore those activities in the intervening period after a disaster, if properly planned and executed, may reduce the severity of the next disaster.

The components of disaster risk reduction cycle, from the time immediately following a disaster are [adapted from MHA, 2019]:

1. Response (including search and rescue if applicable)
2. Relief
3. Rehabilitation
4. Recovery
5. Risk mitigation
6. Risk reduction
7. Prevention
8. Preparedness
9. Warning

Response and relief are relatively short-term activities with the primary objective to ensure relative safety of the survivors. In case of casualties, search and rescue are carried out immediately after the disaster. Rehabilitation is a longer-term activity. In case of widespread disasters such as earthquakes or cyclones, the rehabilitation may last for several years. During rehabilitation, the objective is to restore the condition of the affected people similar to that before the disaster, if not better. Rehabilitation phase may require large-scale development of infrastructure. It may also require relocation of the people from their earlier more vulnerable habitats. The rehabilitation phase thus provides opportunity to reduce underlying vulnerability of the physical infrastructure and built environment before the disaster, in case it was deficient.

The next phase of disaster risk reduction cycle, which generally runs concurrently with rehabilitation, is recovery. During this phase, the focus is on resumption of economic activities (both industrial and agricultural) in the affected areas. In the aftermath of major disasters, there may be loss of employment-generating activities. Often, the recovery phase also focuses on creation of more resilient economic activities that are less prone to disruptions due to disasters. This may require changes in the type of economic activities, and suitable modification of economic policies, such as tax incentives, may be required to encourage creation of resilient activities. The accomplishments during rehabilitation and recovery can reduce underlying vulnerability of vulnerability to next disaster and thus decrease the risk to future disasters.

Certain actions may be taken in parallel with rehabilitation and recovery to reduce the impact of similar disastrous events in the future. These may include improving construction standards, enhancing compliance of the standards, etc. These do not influence the hazard but can reduce its impact on the exposed elements. Such activities are typically categorised under risk mitigation. Some other activities can directly reduce the risk. These may include construction of tsunami barriers in vulnerable zones so that the force of tsunami waves or inundation level can be reduced. These actions, like in the cast of risk mitigation actions, do not influence the hazard. But, unlike the case of risk mitigation actions, the risk reduction actions reduce the consequences of the hazard by reducing its impact on the exposed element instead of strengthening the exposed elements.

Certain actions can prevent disasters from occurring. Such activities are often directly influencing the hazard from occurring, or causing it to occur with reduced ferocity. For example, improvement in vector control and waste management in our cities can reduce, if not eliminate, vector-borne epidemics from occurring. The actions categorised under preparedness are typically undertaken with the occurrence of the hazard is imminent. Preparedness activities would include construction of cyclone shelters in vulnerable zones so that the people at risk can be moved to these shelters when cyclone warnings are issued.

The last category of actions is typically associated with slow-onset disasters that provide sufficient time to warn the people at risk. Different levels of warnings can be issued, ranging from watch to alert.

The risk reduction components are mainly based on government actions. Some activities under these components may be specific to a disastrous event and may constitute a specific action to a particular situation. But, most other activities are related closely to routine developmental agenda. Therefore, it is possible to integrate several disaster risk management activities with normal government programs. But, this poses several challenges: (1) Since only some activities can be taken up at a time, there is insufficient guidance regarding prioritisation; (2) Cost-benefit of the activities are not known to fully evaluate their impact in making the risk of future disaster less severe; (3) Important new required activities may not be considered as past precedence of their implementation is not available; and (4) The effect of the actions on the change in risk profile is not known. Due to these reasons, it is often apprehended that disaster risk reduction activities are not sustainable and interest in these activities rapidly wanes with time.

The challenges outlined above in implementing disaster risk reduction initiatives can be substantially overcome by the use of scientific knowledge to understand the risk in terms of scenarios of various what-if events or projections of the impact of occurrence of various hazards. These disaster risk scenarios, as mentioned above, have been recognised under Sendai Framework for Disaster Risk Reduction 2015-2030 as a central pillar of sustainable risk reduction.

5. DISASTER RISK SCENARIOS

Disaster risk scenarios or simply risk scenarios are projections of the consequences of hypothetical hazardous events. The disaster risk scenarios may be deterministic, in which case the scenario development considers the occurrence of a particular hazardous event in terms of its size, location and time. Sometimes, several deterministic scenarios may be developed to provide information on a range of hazardous events. Another approach that is sometimes adopted is to carry out probabilistic scenarios. In this case, the scenario development is carried out for a large number of events on the basis of their relative probability of occurrence. The consequences are also assessed and, based on the number of times a particular outcome occurs, the probability of occurrence of various outcomes are estimated. The results of probabilistic scenarios are not specific information regarding the effect on elements exposed to the hazard, but in terms of probability of different effects on the exposed elements. Probabilistic risk assessment and scenarios are frequently used in insurance industry where similar simulation tools are also used for assessment of other risks. For disaster management, deterministic scenarios are most commonly used as they permit easy understanding of the influence of underlying factors that govern the risk.

The results of these scientific analyses are typically presented as disaster risk scenarios. The risk scenarios are not forecasts but are projections. These may seem similar but are fundamentally different. Forecasts are predictions of the end results, such as forecast of future temperature by the meteorological services. The intermediate steps in a forecast are the means to arrive at the final results. Their accuracy is important as they influence the forecast results. But, the intermediate steps are rarely of interest by themselves and do not typically represent decision points. The projections, on the other hand focus on the intermediate steps as well as the final results. A projection represents the likely final outcome based and does not take the form of a prediction. In projections, the importance of various intermediate steps on the final results and the sensitivity of final results to different parameters in intermediate steps are also of interest. Sometimes, as in the case of disaster risk scenarios, the intermediate steps and their parameters are of greater interest than the final projections. The projections thus provide science-based and model-centric information regarding the influence of intermediate steps on the final outcomes. They also enable understanding of the influence of values of various intermediate steps to the final results. The projections are also able to provide understanding regarding the extent to which a particular intermediate step needs to be modified in order to achieve the desired final outcome. These scientific assessments thus not only provide comprehensive understanding of the influence of intermediate steps on the final results, but are also able to provide understanding regarding the sensitivity of the intermediate steps on the final outcomes. The disaster risk scenarios, when scientifically developed can act as an invaluable decision support tool to identify the main contributors to risk and the most appropriate interventions to reduce these risks.

The field of disaster risk scenarios is only a few decades old. Some early scenarios were based on benchmarked with already known occurrence of a past disaster [Arya, 1992; West and Lenze 1994].

The use of disaster scenario was popularised after the development of HAZUS by the US Federal Emergency Management Agency in the 1990s [FEMA, 2001]. HAZUS was a comprehensive earthquake risk scenario development tool intended for use in the USA. The simulation tool made use of geographical information systems (GIS) so that the inputs and outputs could be displayed in easy-to-understand maps. The software tool also included information from their census and several other government sources so that the data requirement by the user to carry out disaster simulations was reduced, making the tool usable to non-experts. Several choices made by the HAZUS development team, such as the use of Geographical Information System, etc. have now become the standard norm for disaster risk scenario tools. Since the first release of HAZUS, it has been periodically revised to incorporate the advancement in science from time to time. The software tool has been expanded so that, in addition to earthquake hazard, it can develop disaster scenarios due to flood, tsunami and hurricane hazards [FEMA, 2020]. The scenario results of HAZUS are presented in terms of physical losses, social losses (such as human casualties, and hospitalisation requirements) and financial losses. HAZUS is primarily intended for use by government officers in the USA. It provides information that they can use for planning risk management strategies and to respond after a disaster. HAZUS thus represents a fundamental new approach in the governance of disaster risks.

Simulation tools with similar objectives as HAZUS that are applicable to other regions of the world have been also developed. Some of the simulation tools include Radius [IDNDRS, 1999], HAZ-Taiwan [Yeh *et al*, 2006], and RISK-UE [Spence and Le Brun, 2006]. More recently, an innovative earthquake disaster risk scenario simulation tool, known as OpenQuake, has been developed under the Global Earthquake Model project [GEM, 2020].

To be useful to the disaster risk management community, particularly the government, the disaster scenario software tool should recognise the needs of the users, and provide information that can be helpful for taking various decisions. Most simulation tools that have been developed worldwide are primarily scientific tools with limited understanding of the requirements of the end users. As a result, unlike Hazus, they are rarely used as an integral part of the government's decision-making process.

5.1 Risk Scenarios using RISK.iitb

In India, a disaster risk assessment tool, RISK.iitb has been developed at IIT Bombay [Sinha *et al*, 2008]. RISK.iitb is a GIS-based deterministic seismic risk assessment tool and provides projections of the consequences of a scenario earthquake. The data requirement in this system takes into account the ground realities of available data in India. Several important information that are based on domain-specific knowledge are built-in so that they are not stumbling blocks for non-scientific users. The meta-structure of risk assessment methodology of RISK.iitb is shown in **Figure 1**.

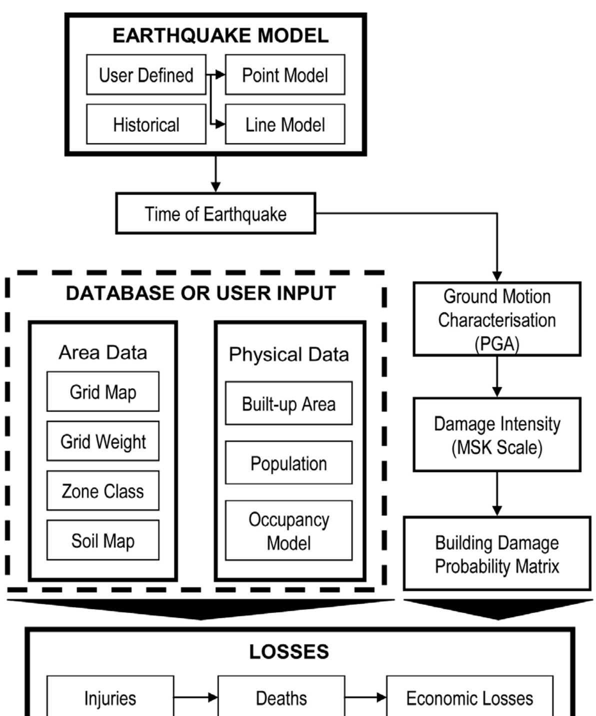

Figure 1: Risk assessment methodology in RISK.iitb for developing earthquake risk scenarios [Sinha *et al*, 2008]

The development of reliable risk scenarios for various hazards in India are constrained by a number of factors. Often, there is insufficient scientific information on the sources of hazards and their recurrence rates. As a result, it becomes difficult to consider the most appropriate "scenario" hazard for carrying out further assessments. This can be resolved by considering a number of hypothetical scenario hazards so that a range of consequences depending on the severity of the considered events. In countries with longer experience of using risk scenarios for disaster risk management, the scenario hazard parameters are sometimes decided jointly by the scientific team and the government agencies. This requires that the governments agree to one or more "target" levels of hazard for risk scenario, and consequently for their disaster risk management plans.

RISK.iitb considers the requirements of government agencies and has been used for developing disaster risk management plans. The city of Mumbai developed its Disaster Risk Management Master Plan (DRMMP) based on earthquake risk scenarios using RISK.iitb. For the DRMMP development, two magnitudes of earthquakes were considered, M6.0 and M6.5. These were jointly decided by the scientific team, disaster risk management experts and the government officials involved in the development of DRMMP. In yet another case, RISK.iitb was used for developing scenario following a major earthquake in northern Himalaya affecting the states of Himachal Pradesh, Punjab and Haryana. For this work, which was carried out in partnership with the National Disaster Management Authority (NDMA) , the decision regarding the target earthquake was taken jointly by NDMA and the IIT Bombay scientific team.

Development of risk scenarios also require information regarding assets that would be exposed to the hazard. In India, information regarding housing types are available from the Housing Census of India. Scanty other information is available from with the governments or in scientific literature. The step therefore requires specific information or the use of proxy information depending on the objectives of the risk assessment and the final risk communications strategy.

As discussed earlier, the scenario results should be relevant to the user organisations. Certain information may be of interest for awareness generation regarding the risk. Such information often provide an overall perspective and are not detailed to help identify its principal contributors. **Figure 2** shows the location of earthquake sources near Mumbai and the epicentre of the scenario M6.5 earthquake. projection of ground shaking during scenario earthquake affecting Mumbai. The strength of ground shaking due to the scenario earthquake, in terms of damage potential or seismic intensity, is shown in **Figure 3**. The information regarding sources of potentially damaging earthquakes near Mumbai and the strength of likely shaking have been widely used in Mumbai for awareness raising of the government officers as well as the public. Mumbai does not have past information regarding a damaging earthquake in public's living memory. These scenario results were found to be very helpful for developing consensus regarding the need to consider earthquake risk for the city's disaster risk management plan.

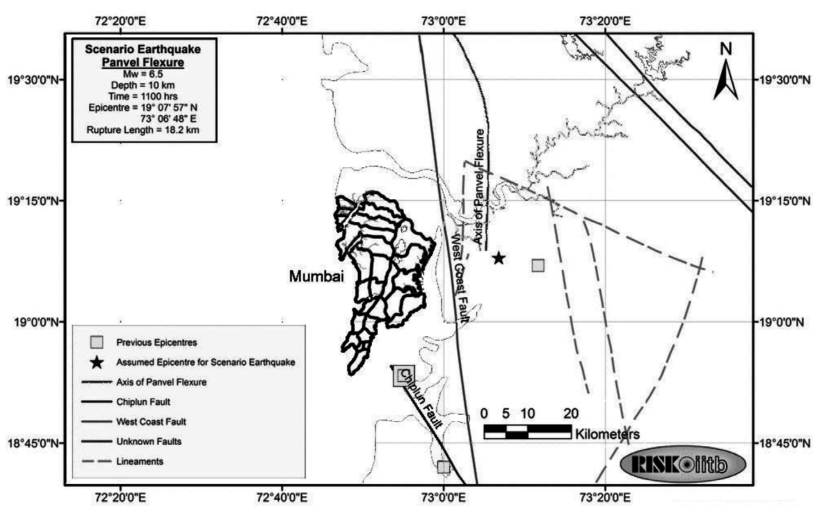

Figure 2: Earthquake sources near Mumbai and the epicentre of scenario M6.5 earthquake. The solid black lines show the administrative wards of the city

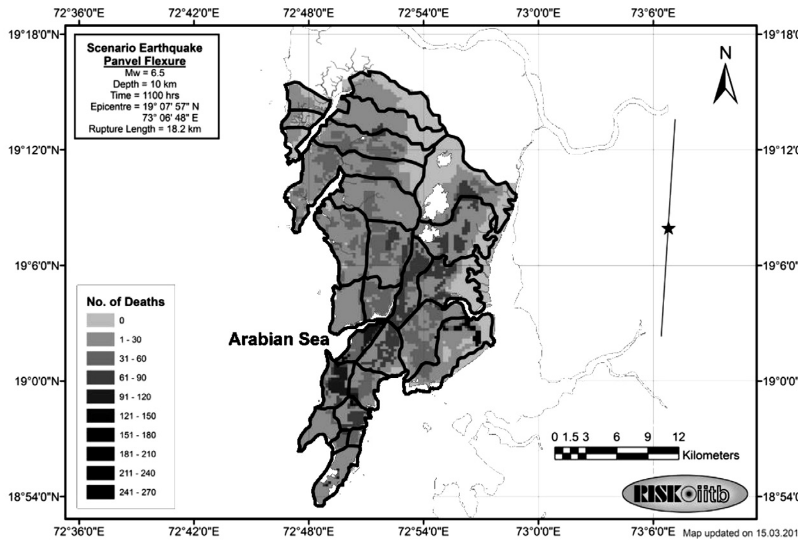

Figure 3: Strength of ground shaking in terms of damage potential (or seismic intensity) due to an M6.5 scenario earthquake affecting Mumbai

The disaster scenario development was also used to estimate the human casualties due to the scenario earthquake. The casualties, in terms of injuries and deaths help to understand the "size" of the problem. Based on this information, which is instantly comprehensible to government agencies, the level of government hierarchy at which this issue should be dealt becomes apparent. These simulation projections thus provide actionable information to the government agencies. **Figure 4** shows the projection regarding deaths due to the scenario earthquake. The information is available for the city as a whole, as well as the places where higher casualties are likely. The casualties depend on the number of people in the buildings at the time of occurrence of the earthquake, the strength of ground shaking which depends on the magnitude of the earthquake, distance from the building and local soil characteristics, the strength of the buildings to withstand earthquake ground shaking, the nature of building damage, etc. In the case of Mumbai, which has a large slum population, the scenario also provides the differences between the casualty profile of occupants of authorised and slum buildings.

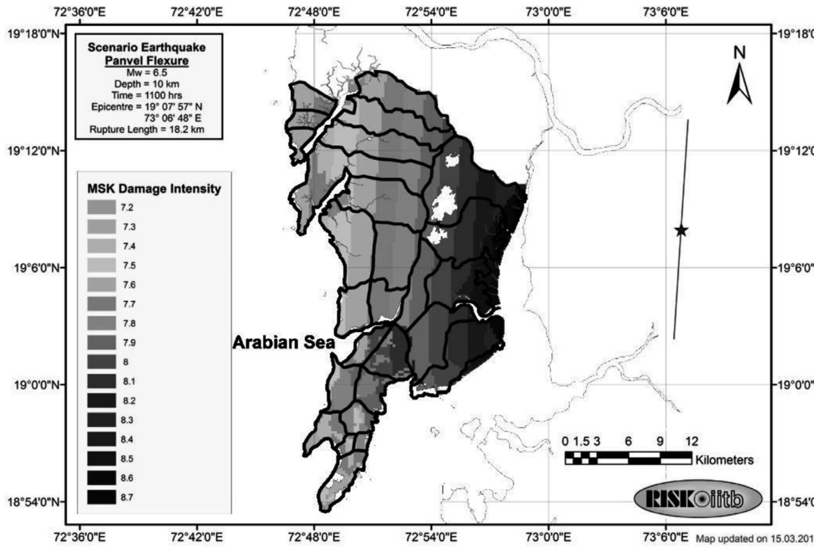

Figure 4: Estimated deaths due to an M6.5 scenario earthquake affecting Mumbai

The underlying causes of human casualties (both their number and geographic distribution) can be traced back to their underlying causes. In the case of complex outcomes such as casualties, a large number of intermediate factors contribute to the final tally. Some of the factors, such as size of the earthquake and local amplification of earthquake shaking due to soil type, can not be controlled and have to be accepted as basic information for the development of disaster risk management plans. These can be accounted for by avoiding construction in the most vulnerable locations. Such decisions, which can be taken at the city's master planning level, are collectively known as risk-sensitive land use planning. There are other factors that are amenable to intervention and can reduce the total casualty. For example, if buildings are damaged due to their inherent weakness caused by lack of compliance with construction standards, the compliance mechanisms can be strengthened as a part of the city's disaster risk reduction plan. Other factors such as quantum of medical support, search and rescue teams, etc. can also be determined from the scenario.

Risk scenarios also provide the capacity to understand the impact of decisions by the government. In the case of Mumbai disaster risk scenario, the importance of various possible interventions was assessed on the basis of their impact on the overall risk profile. For example, the sensitivity of the estimated risk projections on the data regarding built environment was assessed considering both spatial and temporal data. It was found that the risk assessment for the city as a whole is not very sensitive to improvement of this data. But, the distribution of the risk within the city, and consequently the development of ground-level disaster response plans are highly sensitive to this parameter. As a result, policy recommendations to address the data issues pertaining to this factor were made based on disaster scenarios. Several other important policy, program and plan level recommendations were implemented based on the Mumbai disaster risk scenario. These have had salutary positive effect on the management of disaster risks in the years following the implementation of the city's Disaster Risk Management Master Plan.

6. DISCUSSIONS AND CONCLUSIONS

Disaster risk management has seen a paradigm shift from response-centric approach to a holistic approach focused on risk reduction during the last three decades. This has been possible primarily due to the reorientation of the government's role from rescue and relief to their comprehensive role as an integral part of overall governance. There is consensus that for effective disaster risk reduction, the use of traditional knowledge and experience from past disasters is not sufficient. The international agreements in this domain have also transitioned from advocating role of science in disaster management to advocating understanding of risk as a pillar to now recommending that knowledge of potential risks should be the basis for disaster risk reduction policies.

Disaster risk reduction can be achieved only through suitable policies, strategies, programs and initiatives by the government. These have to be taken under a whole-of-government approach and should not be confined to the activities of a separate group within the government. Sustainable risk reduction also requires the active partnership of stakeholders from outside the government, such as non-governmental organisations, industrial sector and voluntary organisations. The sustainable policies also require clear understanding of risks and priorities for action.

Disaster risk scenarios have emerged as a very important decision-support tool to assist planning and execution of disaster risk reduction activities. The risk scenarios are typically based on rigorous science, use available data and provide information for all stakeholders. The information is available in forms that are actionable by various stakeholders. The risk scenarios also provide the ability to track effectiveness of various measures in terms of changes in the risk profile of the region. The ability of risk scenarios to provide projections on human casualties, immediate relief and shelter requirements, economic losses, etc. enable the relevant stakeholder groups to evaluate risk capacity and devise remedial measures.

References

1. Arya,A.S., (1992), "Possible effects of a major earthquake in Kangra region of Himachal Pradesh," **Current Science**, 62, 251–256
2. CRED, (2015), "The Human Cost of Natural Disasters, A Global Perspective," Centre for Research on the Epidemiology of Disasters, Brussels *https://www.preventionweb.net/files/42895_cerdthehumancostofdisastersglobalpe.pdf*

   Accessed on 26 September 2020
3. CRED, (2018), "Economic Losses, Poverty and Disasters 1998-2017," Centre for Research on the Epidemiology of Disasters, Brussels *https://www.preventionweb.net/files/61119_credeconomiclosses.pdf*

   Accessed on 26 September 2020
4. CRED, (2020), "EM-DAT Database," Centre for Research on the Epidemiology of Disasters, Brussels, Belgium

   www.emdat.be

   Accessed on 26 September 2020
5. FEMA, (2001), "HAZUS® 99 Estimated Annualized Earthquake Losses for the United States," Report Number FEMA 366, Federal Emergency Management Agency, Washington DC, USA
6. FEMA, (2020), "HAZUS," Federal Emergency Management Agency,

Washington DC, USA *https://www.fema.gov/flood-maps/tools-resources/flood-map-products/hazus*

Accessed on 20 September 2020

7. GEM, (2020), "OpenQuake: Global Earthquake Model," Pavia, Italy

   https://www.globalquakemodel.org/openquake

   Accessed on 21 September 2020

8. IDNDRS, (1999), "RADIUS: Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters", Technical Report, International Decade for Natural Disasters Reduction Secretariat, United Nations Office for the Coordination of Humanitarian Affairs, Geneva, Switzerland

9. MHA, (2019), National Disaster Management Plan. Ministry of Home Affairs, Government of India,

   https://ndma.gov.in/images/policyplan/dmplan/ndmp-2019.pdf

   Accessed on 13 September 2020

10. NCDM, (2001), "The Report of the High Powered Committee on Disaster Management," National Institute of Disaster Management, New Delhi

    https://nidm.gov.in/PDF/pubs/HPC_Report.pdf

    Accessed on 13 September 2020

11. Sinha,R., Aditya,K.S.P., and Gupta,A., (2008), "GIS-based urban seismic risk assessment using RISK.iitb," **ISET Journal of Earthquake Technology**, 45 (3-4), 41–63

12. Spence, R., and Le Brun,B., (2006), "Preface," **Bulletin of Earthquake Engineering**, 4(4), 319–321

13. UN, (1994), "Draft Yokohama Strategy and Plan of Action for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation," United Nations, New York, USA

    https://digitallibrary.un.org/record/161609?ln=en

    Accessed on 20 September 2020

14. UNDRR, (2015), "Sendai Framework for Disaster Risk Reduction 2015-2030," United Nations Office for Disaster Risk Reduction, Geneva, Switzerland *https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030*

    Accessed on 19 September 2020

15. UNDRR, (2020), "Disaster Risk Reduction Terminology," United Nations Office of Disaster Risk Reduction, Geneva, Switzerland

    www.undrr.org/terminology

Accessed on 19 September 2020

16. UNISDR, (2005), "Hyogo Framework for Action," United Nations International Strategy for Disaster Reduction https://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf

    Accessed on 19 September 2020

17. West,C.T., and Lenze,D.G., (1994), "Modeling the Regional Impact of Natural Disaster and Recovery: A General Framework and an Application to Hurricane Andrew," I**nternational Regional Science Review**, 17(2), 121-150

18. World Bank, (2020), "Disaster Risk Management Overview," https://www.worldbank.org/en/topic/disasterriskmanagement/overview

    Accessed on 26 September 2020

19. Yeh,C.-H., Loh, C.-H., and Tsai,K.-C., (2006), "Overview of Taiwan Earthquake Loss Estimation System," **Natural Hazards**, 37(1-2), 23–37

C. DISASTER-SPECIFIC TRACKS IN DISASTER MANAGEMENT

R. K. Bhandari

Preventing Losses from Landslides

Abstract: The paper delves deeply into the multiple ways-visible and invisible, direct and indirect, by which the losses on account of landslides could be prevented, contained and controlled. More importantly, it recalls the oft- forgotten policies, promises, experiences and the wealth of published and unpublished literature to show the way forward towards landslide risk resilience. The road from the struggle for preventing losses to the landslide-safe destination will be well paved only if we are prepared to construct it upon the bedrock of the lessons learned and the experiences gained. Success will be well within our grasp if only we can objectively size up the problems, understand landslide risks, strategize better, mobilise synergy of strengths, and make judicious use of the unprecedented power of Science and Technology. No matter what we do and how hard we work, the real feeling of fulfilment will come only if we are able to nurse the culture of safety against landslides as we move forward. Let our love for Nature and the accumulated pain of the inheritance of losses from landslides redouble our resolve to achieve the long awaited transformational change.

Landslide disasters can no longer be labelled as natural because they are indeed more manmade than natural. In the fragile multi-hazard ecosystem, our mountains are already under severe pressure of ecological degradation, ill-planned urbanization, rapid pace of development and non-engineered construction, not to speak of the headwinds of climate change. There is urgent need therefore to integrate disaster mitigation initiatives into development planning. Ad hoc and piecemeal approaches to slope stabilization may of course provide some temporary reprieve by reducing losses but would

prove frustrating and expensive in the long run. Selective treatment of landslide hotspots may also reduce site specific landslide risks for some time but lasting solutions can only come by holistic treatment of the mountain system as a whole, aiming at multi-hazard risk resilience.

Key words: Landslides, Geohazards, Disasters, Multi-hazard, Landslide Losses

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1. THE GLOBAL PERSPECTIVE

Landslide disasters rank among disasters of major concern across the world as they pose a major threat to life, properties, infrastructure and environment, especially in the mountain areas. According to the Centre for Research on Epidemiology of Disasters (CRED), landslides cause at least 17 % of the natural disaster inflicted fatalities in the world [Laccase and Nadim, 2009]. A document released by National Institute of Disaster Management on the occasion of 7th Asian Minister's Conference quoted the world-wide natural disaster trends showing alarming increase in climate related disasters for 1980-2013 from Munich RE but no specific figures were provided for landslides. According to an earlier document on Preventing and Mitigating Natural Disasters released by the World Meteorological Organization in 2006, Landslides and Avalanches constituted 6% of weather, climate and water related hazards. For India, there are yet no reliable statistics of fatalities and losses but the fact remains that the landslide scenarios are becoming deadlier, and the damages and the losses from landslides are steadily on the rise. The statistics reported by different agencies do not usually come with the credible evidence of the quality of the sources data. Some agencies place landslides under the category of weather, water and climate inflicted disasters. Some others recognise them as hydro-geological disasters. It is high time we rejected the statistics and such classifications which ignore human violence against mountain systems, and not even account for anthropogenic factors. In most cases, meteorological events only serve as the last straw that breaks the camel's back!

India should effectively engage with the rapidly evolving international partnerships to strengthen its own landslide risk reduction plans and programmes. During the World Conference on Disaster Risk Reduction held in Sendai on 16 March 2015, ICL (International Consortium on Landslides) proposed its partnership 2015-2025 with ISDR (International Strategy for Disaster Reduction) for global promotion of understanding and reducing landslide disaster risk. This was closely followed with the 4th World Landslide Forum from 29 May to 2 June 2017 in Ljubljana, Slovenia, in which the ways and means to strengthen inter-governmental network and International Programme on Landslides (IPL) was discussed. Further, a high level panel met on 30 May 2017 to discuss the draft for the 2017 Ljubljana Declaration on Landslide Risk Reduction and the concept of the Kyoto 2020 Commitment for global promotion of understanding and reducing landslide disaster risk. The Kyoto 2020 Commitment aims at long term, wider and stronger framework for global landslide risk reduction framework. The details and follow-up actions are reported in literature [Sassa, 2018; Sassa, 2019]. The emerging ideas, developing multilateral cooperation programmes and the global knowledge network renew hope of a united global fight against landslides.

2. THE INDIAN RESPONSE

India is internationally well recognized for its policies, programs and achievements in the field of Disaster Risk Reduction (DRR) for Sustainable Development. It is seized of its national and international commitments. The second meeting of the National Platform for Disaster Risk Reduction organised by the Ministry of Home Affairs on 15-16 May 2007 not only discussed several concept notes including the one on Understanding Disaster Risk but also aimed at making India Disaster Resilient by 2030. The broad framework outlined by India, inter alia, focussed on assessment of potential losses and tracking of actual losses. Topics such as monitoring progress against Sendai Framework and Data Readiness; Legal and Institutional mechanisms and strategies connected with Response, Recovery and Rehabilitation also were discussed. The Prime Minister of India placed before the nation a 10-point agenda on DRR at the 7th Asian

Ministerial Conference hosted by India in November 2016. This includes landslide risk resilience.

Historically speaking, India was the first country in the world to pro-actively take global initiative when it hosted the historic, first highly successful International Symposium on Landslides (ISL) in New Delhi in 1980, coordinated by the author. It is to India's credit that ISL 1980 became the mother of successive four-yearly ISL events held in Canada (1984), Switzerland (1988), New Zealand (1992), Norway (1996), Cardiff (2000), Brazil (2004), China (2008), Canada (2012), Italy (2016) and Cartagena (2020). The author initially represented India at the ISLs held in Canada and Switzerland; presented state of the art reports on Prediction and Early warning against landslides based on studies done in India; served the International sub-committee of the International Society of Soil Mechanics and Foundation Engineering on landslides (1982) as Secretary-at-large; ISSMGE's landslide Committee (1988-89); and the International Commission on Landslides (1981-89), as a Member. There was a continuous flow of published literature on landslides, exchange of new ideas and initiatives to forge partnerships, which gradually diminished over the last few years. It is rather unfortunate that there is currently not even a single library in India where Indian scholars and disaster managers could access and benefit from the proceedings of major global events on Landslides, including the ISLs. The current initiative of NIDM to establish a world class library with global networking needs to be fully backed with adequate funding to ensure early establishment of a National Library.

The author currently represents India at the International Joint Technical Committee of Federation of International Geo-Engineering Societies on Natural Slopes and Landslides (JTC) for the period (2015-2021). But it is participation at a personal level. India's formal engagement with JTC on landslides is extremely important not only because JTC contributes substantially on matters related to landslide risk reduction, but it has a patronage of a large number of international professional bodies, including ISSMFGE, ISRM, IAEG, and IGS. NDMA, NIDM and professional bodies (like INAE and IGS) in India should take a serious note of the tremendous gains that can accrue to India by fostering, promoting and sustaining partnerships with relevant international bodies, like the JTC.

2.1 Natural Hazards, Manmade Disasters and Loss Prevention

Hazards like landslides, earthquakes and volcanoes on pristine lands are to be regarded as nature's safety valves on auto-pilot to maintain Earth's dynamic equilibrium because we live on the surface of an unfinished planet. The mountains of the world are meant by Nature to decay otherwise there will be no fertile plains. For centuries, landslides have come and gone, and these were convincingly explained in terms of the irrefutable laws of nature. The fragile ecology, immature geology, meandering rivers, snow bodies, climatic variations and cloudbursts of the mountain systems do have their own dynamics and they are after all our inheritance without choice. But, the difficulty begins to arise when we, without due diligence, call every landslide disaster - a natural disaster- and then rush to provide explanation to shun accountability, knowing well that nature is mute and would not come to plead its own case!

There was a time in history when landslides were natural processes driven by gravitational, seismic or hydro-geological factors sculpturing pristine slopes over the geological time scale. Then came a time when engineers dealt with landslides as isolated hazards partly due to natural factors and partly because of site-specific anthropogenic factors. The situation, by and large, is very different today as most of the landslides are neither natural nor do they occur in isolation. Generally, there are multiple natural and anthropogenic causative factors, which may combine in different ways over a period of time to trigger a landslide. When slopes are neglected, landslides generally grow either progressively or retrogressively. The growth of such landslides could be much faster and mechanism of their development may become more complex when the area is multi-hazard prone. For instance, an earthquake or an extreme weather event could cause bursting of a glacial lake thereby generating flash floods. These flash floods in turn may trigger landslides, and dam rivers, the bursting of which may result is riverine flooding and more landslides. Buildings, roads and other infrastructure at such locations can be protected only by making them multi-hazard resilient. The greatest lesson is therefore to look at occurrences of landslides from a multi-hazard lense, deploying multi-disciplinary teams.

2.2 Indian Landslides and the Great Message

Landslide hotspots are spread over large parts of India, especially in the Himalayas, the North-eastern hill ranges, the Western Ghats, the Nilgiris, the Eastern Ghats, and the Vindhyas. The North-eastern region (the Darjeeling district of West Bengal, Sikkim, Tripura, Meghalaya, Assam, Nagaland and Arunachal Pradesh) too is bristling with landslide problems of a bewildering variety. It is writing on the wall that landslide hazards will become even more devastating, if we continue with business as usual, hardened mind-sets, neglect of environment, growing ill-planned urbanization, non-engineered construction and tooth-less techno-legal regime.

Landslide disasters have been our best school masters for decades on end, and yet they need to repeat the very same lessons over and over again with ever increasing school fee in the hope that one day we will learn the lessons, tighten our belts, take control of the problems staring us in the face, and vow not to create any more of them because we can take no more. The cry of pain of landslide disasters becomes louder with loss of lives, property and economy, not to speak of the heart breaking inheritance of loss.

3. WHERE DOES THE PROBLEM LIE?

Most countries of the world, including India, have been busy formulating policies, preparing strategies, drafting over-arching framework documents, building institutions and revamping disaster management apparatuses. Why then we have not succeeded in flattening the curve of disasters and why is the situation is going from bad to worse?

Centuries ago, Seneca the Younger, who was a Hispano-Roman Philosopher, said: "If a man does not know to what port he is steering, no wind is favourable to him." For preventing losses due to landslides, we have to strike at the root cause of landslides and not just look for mere protection against them. For preventing landslides, we have to learn to anticipate the problems before they strike us. In other words, we have to understand landslide hazards, vulnerabilities and risks by projecting credible site specific scenarios through mapping. India has hugely invested in the landslide hazard mapping over the period of many decades. Let us put together all the landslide hazard maps prepared to date at one place, and find out how many of them have moved out of the Atlases to guide our policy makers, planners, architects, engineers, builders and disaster managers? The problem lies in the fact that we are still looking for our first user-friendly, field validated and peer-reviewed large scale landslide hazard map of any part of our country. If we dig deeper to unravel the truth, we will see a glaring disconnect between the small scale landslide susceptibility maps we produce and the large scale credible landslide hazard maps we need.

The problem does not stop here. Our landslide hazard mapping programs, in their comfort zones, ignore vital factors such as human violence against Nature, climate change, mindless urbanisation and non-engineered constructions. By convincing one another that impacts of human violence can be ignored on the mountain system of fragile ecology or by somehow convincing decision makers, the professionals only speak half-truth that further fuels the fire of disasters. Let us always remember that 'a scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it' [Max Planck].

The other startling revelation which is even more serious is that despite decades of engagement and investments in hazard mapping, there is yet no single nationally accepted uniform approach to landslide hazard mapping. Different knowledge institutions have produced landslide hazards maps using different methodologies. Moreover, these maps were developed at different times and seldom updated, not to speak of revalidation.

Although the credibility of the landslide risk assessment directly depends on the quality of scientific investigations and yet, professional teams across the country continue to remain without a well -crafted and peer reviewed Standing Operating Procedure (SOP).After nation-wide consultations and due diligence at the national level, Indian National Academy of Engineering had found that the only SOPs notified by the Geological Survey of India is grossly deficient [NAE, 2015]. Immediate steps are required to fill this major void.

Losses from landslides can be dramatically reduced if the Detailed Project Reports are well engineered and sound. But, if one were to review Detailed Project Reports connected with projects in areas of landslide hazard, one would invariably find disproportionate focus on identification of market driven technologies to protect slopes in an adhoc manner rather than aiming at prevention of losses from landslides by building straight over the findings of evidence based geotechnical investigations. It is time to create first pace-setting examples to demonstrate how a package of technologies engineered for landslide remediation ought to be rooted in scientific investigation by a multi-disciplinary team.

Even if the choice of a landslide management package is made out of a long list of options, one would need to do a critical socio-economic-eco impact analysis. For instance, there could be predominantly *green* packages (involving afforestation, vegetative turfing, slope and sub slope drainage, etc.) in staggering contrast with predominantly grey packages (involving Gabion walls, Geocell walls, anchored walls, drilled shaft walls, tieback walls, anchors, bolts, piles, nailing, netting, fencing, reinforcing technologies, etc.). Then, there could be packages of control measures, which may draw upon a mix of green and grey technologies. By promoting green technologies, we create better appreciation of their capacity to reduce, buffer and mitigate landslide risk. Our concerted effort should be to implement the recommendation in letter and spirit.

In India it has become a common pastime for some professionals to link catastrophic landslides events with the intensity of rainfall preceding those events. Knowing well that landslides are caused by interplay of a large number of causative factors and their synergistic or cascading effects spread over long periods of time, the wisdom of recognising rainfall alone as an indicator for early warning is totally misplaced. India needs pace setting examples for early warning against landslides based on study of interplay of multiple causative factors, elucidation and characterization of slide boundaries, monitoring of excess hydrostatic pressures and stability analysis in terms of effective stress. Composite warning systems are a must for multi-hazard ecosystem.

4. DIRECT & INDIRECT LOSSES DUE TO LANDSLIDE DISASTERS

It will be a big mistake to reduce the losses from the landslides to merely head counts of lives lost, damages to infrastructure and economic disruptions. Did we ever pay attention to the lasting damages done by landslides and the resulting inheritance of loss which will affect generations to come? Many of the ancient heritage structures already destroyed by landslides are not even known to the present generation and those on the verge of destruction at this time, due to the impending landslides, may perhaps never be known to the future generations, other than from the books of history. Kiran Desai, in her book –The Inheritance of Loss-beautifully sums up: "The present changes the past, looking back you do not find what you have left behind." There is no way we can compensate for some of the losses due to landslides because, in her words, "Could fulfilment be felt as deeply as loss?"

Let us take one of the better documented examples of the two great landslide tragedies which struck the village of Malpa on the pilgrim route from Dharchula to Kailash Mansarovar in Uttarakhand State [INAE, 2017]. In the 1998 catastrophe, the human lives lost of were found to lie in the range 207-209 of which 182 were male and 27 female. These included the pilgrims of the 12th batch (60:46 males plus 14 female); labourers of Ground Engineering Reserve Force (9); guides of Kumaun Mandal Vikas Nigam (5); porters (59); locals from villages Gunji, Budhi and Dumling (44); members of 5 families of Malpa (16); members of the Indo-Tibetan Border Police (8); constables of Uttar Pradesh Police (3) and a hermit (1). Do we know what pain their families are going through at this time?

In the same disaster, a large number of animals were killed which included 40 horses, 29 mules, 11 cows, 7 calves, 1 bullock, 7 goats, and 99 hens. Additionally, houses of the 5 families of Malpa, 2 huts of KMVN, 2 huts of PWD and 1 hut of army were destroyed [INAE, 2017]. Have such statistics ever been documented for other landslides disasters? What is the short- and the long-term impact of such losses on the kith and kin of the deceased? Surprisingly, no dogs were killed because they sensed the danger and escaped. Horses and mules were killed because they were bolted. Have we benefited from such experiences?

Further, the Malpa disaster devastated 0.408 ha of cultivable and 1.70 ha of barren landmass which went down into the Kali River on 18 August 1998. About the same time, during 11-19 August 1998, widespread landslides affected 20 km^2 of the Okhimath area in the catchments of rivers Madhyamaheswar and river Kaliganga, in two phases. The first event took place on 11-12 August 1998 throughout the area. On 18-19 August 1998, the massive landslide at Bhenti Paunder blocked the course of Madhyamaheswar, damming the river for about 12hours to 24 hours. Upon breaching of the landslide dam, a 1.2 km long, 50-70 m wide and 25m-30m deep lake was left behind. In all, during this period nearly 103 people were killed, 29 villages suffered heavy damages and about 10,000 people were affected. The suspension bridge at Jugasuon the Madhyamaheswar river was washed away. The Okhimath-Mansuna road sank by 10-40cm developing 10-150m long cracks. Cracks were found on many places along Guptakashi-Kedarnath road. The loss of livestock was 422. Nearly 820 houses were affected [Bisht and Shah, 1999].

5. THE SILVER LINING

The silver-lining is that despite the dreadful Indian landslide scenarios and persisting threats of landslide disasters everywhere, there is more light in the Indian skies than the darkness we see. Our strength comes from the strong political will, our long and priceless experience, and strong network of knowledge institutions. No sooner did the national Disaster Management Act, 2005, was enacted and National Disaster Management Authority (NDMA) was created by an Act of Parliament, we opted for a paradigm shift from the relief-centric approach to the culture of preparedness, prevention disaster mitigation. The Planning Commission for the first time added a Chapter on Disaster Management in the 12th Five Year Plan document (2012-2017), reaffirming India's commitment to integrate disaster management with development planning. NDMA published Guidelines on Management of Landslides and Snow avalanches in June 2009. Also, we have a large pool of self-taught landslide experts scattered all over the country. During the last half a century, we have investigated, and somehow managed, countless landslides in diverse geological situations and contributed thousands of papers, hundreds of books, monographs, videos and media reports on them. We have the experience of building roads, tunnels and townships in some of most complex and difficult mountain terrains.

Also, India is on the cusp of a most remarkable transition from the use of primitive tools to the adoption of highly advanced technologies for landslide investigations, instrumentation, field monitoring, hazard mapping, slope protection and remediation. In recent years, we took national initiatives to tap the potential of satellite imageries, UAVs, communication technologies, Artificial Intelligence and the GIS. Our meteorological forecasts are timely and near perfect. Our knowledge and understanding of the Indian mountain systems, their ecology, geomorphology, geology, hydrology, geotechnology and seismicity have considerably improved. Many higher institutes of educational and teaching have established Centres of Excellence. Our competence levels in big data processing, mathematical modelling, stability analysis etc have advanced to unprecedented levels. The Indian cabinet has taken many path breaking decisions including approval of the mission to sustain Himalayan ecosystem, accorded on 28 February 2014. There is a designated National Nodal Agency for Landslide Studies. NDMA, NIDM, NDRF, and such other bodies are continuously building their capacities to meet the national challenges.

6. THE WAY FORWARD

The way forward lies in conscientiously following the grammar of Slope Engineering. The three cardinal lessons are:

(1) We must not allow a slope failure to grow from small to big;

(2) If and when a slope failure is observed, we must pro-actively size up the problem, learn from its past history and try to remove the root cause; and

(3) We must continuously build our capacities to solve the problems we face with the honest realization that big problems can be effectively cracked, if we think big. According to John Maynard Keynes, "difficulty lies not in the new ideas, but in escaping the old ones." And as Einstein has said, "we cannot solve the problems we have created with the same thinking that created them".

6.1 Live in Harmony with Nature

Many landslide disasters will cease to occur and losses from landslides can be drastically reduced if we shun violence against nature, nip the slope failures in the bud, respect techno-legal regime and ensure that the high speed development in itself does not become cause of future disasters. In the recent decades, we have witnessed despicable human violence against environment and sharp increase in tragic landslide events so much so that India has become a treasure house of landslides. In all humility, we should concede our wrong doings rather than deflecting accountability. "The most perfidious way of harming a cause consists of defending it deliberately with faulty arguments - Friedrich Nietzsche."

There is a Chinese saying that "a man who removes a mountain begins by carrying away small stones." For decades, we have been removing, not small stones, but mountains of rocks for building townships; widening of roads, and interfering with free flowing rivers to add more and more of dams and reservoirs. Many of the landslides we know are the result of these very actions, which rob the slopes of its equilibrium, load rivers, silt reservoirs and create new land masses in the sea. Many of the landslides which began as small slope failures have grown big, bigger and eventually intractable. We should prevent slope failures by timely engineering interventions, attend to small slope failures on a day to day basis; and deal with big landslides on a war-footing, bearing in mind that lasting solutions will come only by minimising human violence against nature and by taking recourse to environment friendly technologies.

6.2 Understand Landslide Hazard Vulnerability and Risk

For prevention of losses from landslides, first and the foremost, it is important to understand site specific hazards, vulnerabilities and risks. Naturally, a credible assessment of risk in any given case will not be possible if the team of experts lack multi-disciplinary expertise and insights into how landslides develop in different hydro-geological and urban settings. Hazard maps produced without fullest appreciation of multiple causative factors, including the negative effects of human interventions, would invariably yield outputs which are neither reliable nor of any practical utility.

The Hazard and Vulnerability Atlases, published by the Building Materials Technology Promotion Council (BMTPC); the Defence Terrain Research Laboratory and the National Remote Sensing Agency (NRSA) a long time ago, have to be thoroughly peer reviewed and validated from time to time, for them to stay relevant. Take for example, the NRSA Atlas, Volume 1 which refers to the State of Uttarakhand and Volume 2 which refers to the State of Himachal Pradesh. These were produced years ago and have never been revalidated to be credible for use. Also, many of the hazard maps become suspect when areas with clear evidences of landslides appear as safe zones on the maps. High-end approaches and statistical analyses without credible and constant inflow of basic data are worthless. Also the bright colours delineating areas of high or very high landslide hazards will not inspire confidence if the same criteria, when applied to similar situations in the same region, would suggest stability. In other words, consistent and sound logic should explain why landslides occurred where they did, and why they did not occur where similar slopes stand safe for centuries?

Run out effects of Landslides, if not calculated in advance, can be devastating. In case of rapid motion landslides, even the distant roads, buildings, human settlements, bridges and other infrastructure could be affected. Landslides at Varunavat, Sonapur, Nilgiris, Malin Gaon and Malpa are some of the examples.

6.3 Permanently Fix all Major Known Landslide Hotspots

One of the most effective ways of reducing losses due to landslides is to fix them permanently by using eco-friendly solutions. Over the period of decades, we have learned to live with landslides despite their devastating impact. For example, the Kaliasaur landslide at km 350.6 on the Rishikesh-Joshimath-Mana Road in Uttarakhand, has hit us more than 40 times since its inception in 1952, and it continues to remain a problem as it gets bigger by every monsoon season. The Sonapur landslide on NH44 in the Jaintia Hill district of Meghalaya also has been a nightmare for decades. It provides not only a striking example of how appropriate engineering intervention could control a difficult landslide, but also a big sigh of relief to the whole of North Eastern Region.

Another point of great important is to insist on the application of environment friendly technologies for landslide control. Maximum rating should be given to drainage and bio-engineering based solutions. Also, it is of critical importance to ensure that no package of landslide control measures get approved at its face value without a thorough peer review. In other words, the design of protection works and the choice of technologies should be rooted deeply in the findings of the geotechnical investigations.

6.4 Invest in pro-active protection against anticipated landslides

Landslide threats persist in many highly populated regions of India and there are locations where disasters are imminent. The question is not if, but when they will occur? Take for example, our scary mountain roads such as 46.7 km long Kollmalai Ghat Road on the eastern coast of Tamil Nadu with as many as 70 continuous hairpin bends; the 233 km long Keylong-Kishtwar road in Himachal Pradesh and the road to ZoziLa in the Western Himalayan mountain range. Likewise, the railway routes such as the Kangra Valley Railway (1925); Darjeeling Himalayan Railway (1881) and Kalka Shimla Railway (1898). Those who are familiar with the areas see losses due to landslides as a writing on the wall. Investment in pro-active treatment of anticipated landslides, to start with critical locations, is bound to pay rich dividends.

Our attention should also go to the perceived landslide threats on India's strategic roads and pilgrim routes. When landslides struck the pilgrim route to Kailash Mansarovar because of the landslide tragedies at Malpa, the softer option was to look for a new route. Changing routes is not a good solution as it takes away the opportunity to strike at the root of the problem. And how do we know that the new route also will not meet with the same fate? For instance, the new route to Kailash Mansarovar via NathuLa is now operational. The question as to how safe this route, given its own landslide history and ecological fragility of the area. It is worthy of note that in the recent years, NathuLa Changu road was hit by landslides at 15th and the 17th mile, and both these locations are known to be hazardous. At the same location, in September 2012, a major landslide killed 4 people. Again, on 23 July 2014, 130 people were evacuated by the Indian Army when two dozen vehicles got stranded on the road due to a landslide. Naturally, the answer lies in pro-actively fixing the landslides.

6.5 Build National Capacity to remove Adhocism in Landslide Investigation

In credibility of the geotechnical investigations lies the real hope for a sound engineering intervention to prevent losses from landslides. If one were to subject the commonly produced landslide investigation reports to rigorous peer reviews, a large number of inconvenient truths would come to light. A good landslide investigation is one which naturally progresses with the clues provided by the field evidences during surveys; signatures left behind by the landslides, and the lessons learned from the landslide history of the area. But, in actual practice, most investigations begin after field evidences get erased and what is worse, they are largely driven by the inexperienced and untrained teams without even the minimum levels of multi-disciplinary expertise. This highly significant observation can be best illustrated by putting together all the various studies done and reports produced by different teams on the Malpa landslide disasters of 1998 and 2017. A critical evaluation done [INAE, 2015] has revealed that the data reported and papers published by the different investigations teams over the period of 19 years, though important, are in themselves not enough to design control measures and save the township from future threats of disasters. The first thing to do was to produce a large scale site specific hazard map of the areas, which is yet unavailable.

Engineers often deal with slope failures and landslides under severe constraints of time and resource. For dealing with limitations of data and uncertainties, they exercise their engineering judgment to make unavoidable assumptions. So long as uncertainties and assumptions are due to limitations of the state of the art in a given case, they can be covered generally under the margins of safety adopted in engineering designs. On the other hand, if the uncertainties are because of lack of expertise, callous planning, careless handling of landslide investigations, use of inappropriate design procedures and faulty construction practices, it would be wrong to look for protection in the prescribed Factor of Safety.

6.6 Invest adequately in Prediction of Landslides

Karl Terzaghi, the father modern Soil Mechanics and doyen of landslide studies, said many decades ago that 'If a landslide comes as a surprise to the eye witnesses, it would be more accurate to say that the observers failed to detect the phenomena which preceded the slide.' Given the magical advances in Science and Technology, the prediction of landslides, unlike that of an earthquake, is in the realm of a possibility. We have enough of scientific knowledge; experience, tools and techniques of slope monitoring and real time data analysis, processing and communication to predict and avert most, if not all, landslides.

India made a humble beginning in the 1980's to address the excitement of instrumenting, monitoring and predicting landslides and followed it through intensive field studies reported in the three consecutive International Symposia on Landslides held in New Delhi, Toronto and Lausanne (1980, 1984 and 1988). The advocacy of using simple and user friendly instrumentation and measurement technologies proposed then remains as relevant today. Decades ago, communities in India were trained to interpret ocularly visible signs of instability (like subsidence of buildings, sinking of roads, tilting of trees, bulging of retaining walls and frequent falling of rocks) which served as alerts. Today, with the influx of powerful remote sensing and slope instrumentation technologies, trained communities could prove to be assets in disaster mitigation.

Before we invest in predicting first time landslides, which is a difficult thing to do, our urgent attention must go to the array of pre-existing landslides which may often deceptively appear dormant or inactive before they hit us. There are also seasonal landslides which frequently respond to the trigger of a rainfall or an earthquake. There is no rocket science in predicting such recurrences. All we have to do is to keep them under surveillance until they get fixed.

For landslide prediction to be credible, the early warning criteria should be grounded necessarily in holistic analysis and interpretation of landslide hazard history of the area, site-specific real-time rainfall records, seismic records, landslide mechanisms, spatial piezometric variations, slope surface and subsurface movements and movement rates on catchment characteristics, discrete boundary shears, run out effects and other collateral threats in the catchment and on the higher slopes.

Therefore, it is time to launch selected mission-mode projects to initially cover early warning against: (a) possible reactivation of major old, dormant and seasonal landslides, (b) landslides and flash flooding due to bursting of glacial lakes, (c) bursting of landslide dams, (d) first-time landslides in urban and strategically important areas falling in the zone of exceptional landslide hazard, and (e) rock falls.

In the age of climate change, extreme weather events are common. In mountain systems of fragile ecology, extreme weather events (such as a cloud burst) invariably cause slope failures. Most of these occur because of the reactivation of old and dormant landslides. But, it will be scientifically wrong to blame cloud-burst as the cause of such landslide events, without even attempting to understand the slope dynamics in the ecological theatre of Nature. When the great Alaknanda tragedy of 20-21 July 1970 occurred in Uttarakhand, rather than going through the rigours of investigation, it was argued that the previous maxima of 200mm rainfall recorded at Joshimath on 28 September 1924 was crossed by a new high of 212.8mm. Subsequent studies revealed that the tragedy was caused by the bursting of the landslide dam at the confluence of Patalganga and Alaknanda. Further probe traced the landslide dam formation to the enormous charge of debris brought down by Patalganga. And the source of debris was the numerous landslides in the Patalganga valley. If one were to dig deeper, these landslides themselves were the result of neglect, misuse and abuse of our lands for decades.

As meteorological forecasts are becoming more accurate, soon enough it should be possible to even modify the weather for dealing with rain induced landslide disasters by innovative technologies. In February 2016, Uttarakhand suffered from forest fire for over 88 days, destroying 3,000–8,000 acres of land. Rather than waiting for rainfall to extinguish the fire, Uttarakhand could perhaps have taken recourse to cloud-seeding technology to convert clouds into giant sprinklers. In 2008, Los Angeles County officials used silver iodide to seed clouds over the San Gabriel Mountains to ward-off fires. The same year, China employed cloud-seeding technology to bring some rain and clear the air before the Beijing Summer Olympics.

6.7 Engineer proactive Surveillance of Strategic Projects

India is on the path of rapid development with the commitment to itself that development projects will not be allowed to result in disasters. We will never know how well that commitment is being kept in actual engineering practice, until by policy intervention it becomes obligatory to get flagship projects independently reviewed and documented from the angle of multi-hazard risk resilience. Let us consider some examples. India is credited to have built the 8.8 km long Rohtang tunnel, ranked amongst the world's highest, to reduce the distance between Leh and Manali by as much as 46 km. In doing so, it has disturbed the fragile ecology of the eastern Pir Panjal range and accentuated the threat of landslides. Have all such possibilities been accounted for in the implementation of the project, and if yes, how? Such questions must naturally arise, and answered to demonstrate that we walk the talk.

There are far more serious problems associated with many flagship highway projects in terrains of fragile ecology, such as the Chardham project in Uttarakhand which involves 4-laning of an 890km long highway, or the Ramban Banihal highway project in Jammu and Kashmir. Already, both the highways are severely threatened by landslides, and it would require the highest engineering skills to avert disasters in future.

6.8 Rethink the Role of the National Nodal Agency

Geological Survey of India, operating under the Ministry of Mines, is the national nodal agencies for Landslides, since 2004. This decision was last ratified by NDMA in June 2009 over-ruling the dissent during the discussion on the matter. The author, as a member of the NDMA's core committee, had raised the demand for a rethink on the ground that GSI is simply not equipped to provide national vision and the highest level of engineering interventions with multi-disciplinary inputs required to achieve disaster resilience of India's landslide threatened townships, highways and other infrastructure. The decision of the NDMA was driven by the fact that GSI had been involved in geological aspects of slope studies since 1884, and investigation of landslides since 1950. Moreover, its landslide susceptibility mapping work which had started in 1980 mainly on the basic and regional scale (1:50 000), was already expanding to deliver regional and macro-scale landslide susceptibility zonation maps.

By the time Kedarnath tragedy struck Uttarakhand in 2013, GSI had already produced landslide susceptibility maps covering about 60,000 sq km of the landslide prone landmass. GSI had mapped landslide hazards on the Yamunotri, Gangotri, Badrinath, Kedarnath and Kailash Mansarovar pilgrimage routes. But the maps produced being at 1:50,000 scale, were unsuitable for responding to the location-specific studies and problems. In 2014-15, India entered the digital world of mapping with the GSI's launching of National Landslide Susceptibility Mapping (NLSM) programme, and setting the landslide susceptibility mapping target of 4,20,000 sq km of area on 1:50,000 scale by 2020. At that time, 70 GSI officials were engaged in this program throughout India. In Uttarakhand, by 2014, GSI had completed NLSM covering an area of 18,000 sq km.

Recognizing the importance of the subject, Indian National Academy of Engineering took a suo motu cognizance of the matter, initiated an intense consultative process through e-correspondence and later organized two major national level meetings in May and November 2015. It became abundantly clear that LSZ mapping for macro level planning by the GSI was misplaced at a time when the country feels totally starved of the landslide hazard maps at scales of 1:10,000 and larger, and for site specific studies at scales on the order of 1:500 – 1:1,000. Also, it was disappointing to find out that landslide hazard mapping is being pursued by many knowledge institutions, such as ISRO, NRSA, CSRE, WIHG, CBRI and CRRI, were using different approaches to making and were not user friendly. Also, the Standard Operating Procedure for Landslide Investigation proposed by GSI was found to be unremarkable and misleading in many ways and required rewriting.

In any case, with such a long tenure of GSI as a nodal agency, its performance review is overdue. Every effort should be made with adequate investments and empowerment to strengthen the nodal agency and raise it to a truly autonomous multi-disciplinary body so that nation can hold it accountable for what is does; as also for what it does not do. The indicators of performance of an empowered agency should be in terms of the number of disasters prevented, landslides fixed, lives saved, best practice examples established, human resource trained and sound engineering practices introduced. Before the gilt of unimplemented decisions spreads, and neglect of previously made investigation reports filed without action begins to hurt, it will be wise to learn from the past experiences and use those very lessons in forward planning, capacity building and proof-testing of the institutional mechanisms. The INAE recommendations were unanimous, comprehensive and actionable. It is time for the government to review the implementation of the INAE recommendations discussed with NDMA during 2015-2017.

6.9 Tap the potential of Smart Technologies

Smart technologies are like silver bullets in the war against landslides and preventing losses and ensuring that no one is left behind in the crisis times. According to Lucas Joppa, the head of the AI for Earth initiative, "AI will change the way we observe things on Earth, the way we communicate those observations, and the way we classify those observations to meaningful information and the way we make predictions and optimizations". Beside AI, already Remote sensing, Robotics, ICT, Space technologies and Earth Observation Satellites are finding powerful application in all stages of landslide mitigation and management.

Since landslide hazards can no longer be considered in isolation to ensure total safety, power of smart technologies should be fully tapped in landslide investigation, monitoring, multi-hazard mapping, early warning and swift response. During the Haiti earthquake of 2010, a SMS system called TERA (Trilogy Emergency Relief Application) was developed for effective two-way communication between the first responders and the people, even after failure of the network! Also use of social media (like Facebook, Twitter and WhatsApp), if judiciously utilized, will prove to be assets in supporting rescue teams and connecting people in the crisis times. Similarly, losses due to landslides on hill roads can be reduced greatly by making appropriate use of Vehicular Adhoc networks (VANETs) and Unmanned Aerial Vehicles (UAVs). A word of caution is necessary to prevent blind use or dependence on technology, which in itself could become a disaster.

6.10 Tighten the Techno-legal Regime

No matter what we do, the success will continue to elude us if we do not fortify landslide management by introducing sound techno-legal and techno-financial practices. For all ongoing and new development projects involving landslide risk management, the project construction and the corrective action for countering the construction-related, visible or anticipated slope failures and environmental damage before, during or after the construction stage, ought to be considered in design as its inseparable parts. This could be achieved by discontinuing the conventional practice of reflecting the costs of corrective actions as separate budget items, and by creating innovative techno-legal and techno-financial enabling environment.

Adequate budget for the above purpose, including the maintenance costs, must be sanctioned as a package and all major landslide projects should pass through a mandatory peer-review by independent panels of experts [INAE, 2015].

6.11 Update Guidelines, Design Codes & SOPs, and Promote Documentation

Over the period of last several decades, we have drafted guidelines, published monographs, written reports, authored papers, updated design codes, and developed Standard Operating Procedures for landslide investigation. Most of these have outlived their utility and needs independent peer review, revision and regular updating. Vast expanse of hazardous areas has been covered with small scale landslide hazard mapping but without regular revisions and revalidation. They too would lose their values unless regularly updated. The same is true of the printed Atlases. The NDMA Guidelines on Landslides (2009); Landslide related BIS Codes and the Standing Operations Procedures for Landslide Investigation authored by GSI are all overdue for revision.

There are a number of knowledge institutions engaged in guiding research scholars, and training professionals in the diverse aspects of landslide mitigation and management. But, there is a great paucity of trainers trained at the state of the art level.

Credible and comprehensive documentation of landslides and landslide disasters should become part of our routine engineering practice. The emphasis stems from the fact that the universe of landslides is fascinating because *every inch of landslide exposed*, deepens our questions and further taxes our imagination. What a landslide reveals at its surface, if not explored deeper, may sometimes make us conclude at the expense of what is hidden, not-known, unseen or not-understood. Many landslide case-records published after due process of scholarly studies and debate go seldom challenged because *the publications appear scholarly at their face value*. Therefore, the need to write credible monographs is critical.

6.12 Strengthen Communities as First Responders

In situations where landslide disasters occur due to unforeseen factors or because of our own follies, they will necessarily have to be first managed by affected communities and the local government. Generally, the rescue teams and ambulances arrive at the scene of disasters after much of damage is already done, particularly if the area is inaccessible. Therefore, it is of critical importance that communities are equipped, educated and empowered to save lives as the first responders, before the rescue support arrives. By taking care of small resource requirement at the community level capacity building, disproportionately large dividends mat accrue.

7. CONCLUDING REMARKS

The dream of **a** landslide disaster-free India is no doubt a tall order and a daunting task. Given the political will, the impressive network of knowledge institutions, the enormous weight of past experience and the magical power of science and technology at our command, we will certainly make it to the destination, if only we are ready to junk old ideas, admit our mistakes in all humility and raise our imagination to match the size of problems we face.

References

1. Bhandari,R.K., (1987), "Slope Instability in the Fragile Himalaya & Strategy for Development," **Annual Lecture** of Indian Geotechnical Society, IGS Journal
2. Bhandari,R.K., (2007), "The Indian Landslide Scenario: Strategic Issues and Action Points," **Journal of Disaster and Development**, 1(2), NIDM
3. Bhandari,R.K., (2013), "Challenges of devastating Indian landslides," Guest Editorial, **Current Science**, 105(5), 10 September
4. Bhandari,R.K., (2014), "Disaster Management in India – The urgency of fresh thinking," **Vivekananda International Foundation**, 28 August 2014
5. Bhandari,R.K., (2015), "Indian National Agenda for Landslide Disaster Mitigation-Challenges and Recommendations," **Current Science,** 109(5), 10 October 2015
6. Bist,K.S., and Shah,M.P., (1999), "The devastating landslide of August 1998 in Okhimath area, Rudraprayag district, Garhwal Himalaya," **Current Science**, 76(4), 25 February 1999
7. Gupta,A.K., (2016), "Prime Minister's Agenda 10- India's Disaster Risk

Management Road Map to Climate Resilient and Sustainable Development," **NIDM**, New Delhi

8. INAE, (2015), Proceedings of the Roundtable Meetings on Landslide Disasters, Vols. 1 & 2
9. INAE, (2017), *Malpa Landslide Disasters*, **INAE Monograph**, CSIR-NISCAIR
10. Sassa,K., (2018), "Zero Draft of the Kyoto 2020 Commitment for Global Promotion of Understanding of Reducing Landslide Disaster Risk," **Journal of Landslides**, Online, Springer-Verlag GmbH, Germany, 5 February 2018, 15, 389-392
11. Sassa,K., (2019), "The International Consortium on Landslides, the Kyoto Landslide Commitment 2020," **Journal of Landslides**, Online, Springer-Verlag GmbH, Germany, 30 July 2019, 16, 1623-1628
12. Lacasse,S., (2013), "Protecting Society from Landslides-the role of the Geotechnical Engineer," **Eighth Terzaghi Oration**
13. Rautela,P., and Thakur,V.C., (1999), "Landslide Hazard Zonation in Kaliganga and Madhyamahshwar valleys of Garhwal Himalaya: A GIS based approach," **Himalayan Geology**, 20(2), 31-44
14. Sarkar,S., Kanungo,D.P., and Mehrotra,G.S., (1995), "Landslide Hazard Zonation: a Case Study in Garhwal Himalaya, India," **Mountain Reserve Development**, 15(4), 301–309
15. WMO, (2006), *Preventing and Mitigating Disasters*, **WMO**, No.993

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Mitigating Losses During Floods

Abstract : Floods are the most recurrent natural disaster in India causing huge damage to livelihood systems, property, infrastructure, and public utilities. In the recent times, increase in the urbanisation and invasion of coastal and river plains have augmented the flood risk. It is possible to minimize the flood damages and improve flood resilience by developing strategies for early warning, emergency response and mitigation. It is imperative to integrate geospatial tools like Satellite Remote Sensing, Geographical Information System (GIS), decision support tools; simulation models Global Positioning System (GPS), mobile & web technologies etc. Multi - temporal satellite images have become an integral part for flood preparedness, mapping & monitoring, impact assessment and mitigation. This paper discusses the potential of geospatial technologies for flood hazard zonation, river bank erosion/deposition aspects and urban flood mitigation with case studies.

Key words: Satellite data, GIS, flood hazard, bank erosion, urban flood modelling, and decision support tools.

1. INTRODUCTION

Floods have been a recurrent phenomenon in India from times immemorial. Floods of varying magnitude affect some part or the other in the country, almost every year on account of different climates and rainfall patterns. The devastating floods not only result in loss of precious human lives, cattle and damage to public and private property but also create a sense of insecurity and fear in the minds of people living in the flood plains. With the increase in population and developmental activities in the country, there has been a tendency to occupy the floodplains, often resulting in serious flood damages and loss of lives over the years. Floods cause severe bank erosion if the river banks are fragile and not protected against the heavy flood discharges. The river systems are altered by land use changes and cutting off floodplains leading to the loss of retention storage capacity and therefore to increased peak discharges and reduced translation time of the flood wave downstream. This results in far-reaching problems further downstream like increased flood risk following higher peak discharges and changed local hydraulic parameters like higher water levels as well as difficulties in delivery of flood warnings due to reduced lead time [Habersack *et al*, 2015]. About 48% of total flood prone area (40 Mha assessed by the Rashtriya Barh Ayog) of the country has been provided with reasonable protection against flood of a low to moderate magnitude. Due to technological and economic constraints, it is not possible to provide protection against all flood magnitudes. Flood damage data is collected by the State Governments in terms of affected area, crops, cattle, properties, population, *etc*. Based on the statistics provided by the States for the period 1953- 2016, it has been reported that average annual damages by floods in the country are more than Rs.5000 Crore besides the loss of precious human lives and cattle. Flood damages in India during 1953-2016 and the maximum annual flood damages for 1977, 1978, 1979, 2005, 2013 and 2015 are given in **Table 1**.

Table 1: Flood damages in India during 1953-2016 [CWC, 2020a]

S. No.	Item	Unit	Average Annual Damage	Maximum Damage	
				Extent	Year
1	Area affected	M ha	7.2	17.5	1978
2	Population affected	Million	31.9	70.5	1978
3	Human lives lost	Number	1648	11,316	1977
4	Cattle lost	Number	94,104	6,18,248	1979
5	Cropped area affected	M ha	3.9	12.3	2005
6	Damage to crops	Rs. Crores	1,598	17,044	2015

7	Houses damaged	Number	12,41,642	39,59,191	2015
8	Damage to houses	Rs.Crores	694	10,810	2009
9	Damage to public utilities	Rs.Crores	3,121	38,938	2013

Different measures have been adopted to reduce the flood/ erosion losses and protect the flood plains. Depending upon manner in which they work, flood protection and flood management measures may be broadly classified as non-structural and structural measures. Details are given in **Table 2**.

At each phase of the disaster management cycle of mitigation, preparedness, response, and recovery, critical decisions must be made that require getting the right information to the right people at the right time. To reduce or to minimize the losses on account of flood disaster, it is required to understand the lives and the assets that are exposed and are at risk. For this hazard, exposure, vulnerability, and risk information over the region is required. Hence, there is need to develop flood hazard maps for effective flood mitigation, thereby reduce the flood losses. Further, to protect the area various structural flood control measures such as embankments, river training works, bank erosion works etc are constructed. It is to be noted that planning of such works needs latest and accurate information on river such as river configuration, floodplain information besides hydraulic and hydrological information. Geospatial technologies encompass Satellite Remote Sensing, Geographical Information System (GIS), Global Positioning System (GPS) & Communications, mobile & web technologies and crowd sourcing.

Table 2: Flood Mitigation Measures [CWC, 2020b]

S. No.	Non-Structural Methods	S. No.	Structural Measures
1	Flood Forecasting, Flood Warning and evacuation of the people	1	Creation of reservoir
2	Flood Plain Zoning	2	Diversion of a part of the peak flow to another river or basin where such diversion would not cause sizeable damage

3	Flood Proofing	3	Construction of flood embankments
4	Living with Floods	4	Channel improvement
		5	Watershed management
		6	Construction of spurs, groynes, studs, etc.
		7	Construction of bank revetment along with launching apron

In 2004, ISRO launched a comprehensive Disaster Management Support (DMS) programme, in close association with Ministry of Home Affairs (MHA), National Disaster Management Authority (NDMA), Ministry of Agriculture (MOA) and the State Governments for providing timely support and services from aero-space systems, towards efficient management of disasters in the country. A Decision Support Centre (DSC) was established at NRSC, Hyderabad, India as a single window service provider for space based information on disasters to Central and State departments of India. Major floods, cyclones, landslides, earthquakes, forest fires are regularly monitored and mapped in near real time. This information is provided to MHA, NDMA, concerned State and Central departments through mail and also made available through Bhuvan portal [NRSC, 2020]. Encouraging feedback was received from Central and State Departments for the information provided by DSC/NRSC/ISRO.

This paper discusses the potential of the integration of the geospatial tools with case studies for flood hazard zonation, flood hazard index, urban flood modelling, shift in the river configuration and river bank erosion& deposition which are useful for planning effective flood mitigation measures in order to reduce the damage losses.

2. ROLE OF GEOSPATIAL TECHNOLOGIES

2.1 Remote Sensing Satellites

Earth observation satellites covering large areas at various spatial and temporal scales in real-time have become valuable sources of information related to atmosphere and earth surface. Polar orbiting satellites have the advantage of providing much higher spatial resolution imageries, even though at low temporal frequency, which could be used for detailed monitoring, damage assessment and long-term relief management. Today remote sensing technology for flood disaster remains a rich source of information that can provide disaster footprints of higher accuracy useful for assessing the disaster impact and taking up flood mitigation activities [Sanyal and Lu, 2006; Bhatt *et al*, 2010; Manjusree *et al*, 2012; Manjusree *et al*, 2014; and Bhatt *et al*, 2016]. The integration of GIS technology not only enables visualization of flooding but estimate probable damage due to flood [Hausmann *et al*, 1998; Clark, 1998]. Geo-stationary satellites provide continuous and synoptic observations over large areas on weather including cyclone monitoring [Jayaraman, 1997]. **Table 3** shows the earth observation satellites for flood disaster management.

Table 3: Satellite and sensors used for flood disaster management

S. No.	Satellite	Sensor	Resolution	Mode	Source
1	Aqua, Terra	MODIS	250 m, 500 m, 1 km	Multispectral	NASA
2	Ocean SAT	OCM	360 m		ISRO
3	Radarsat	SAR - Microwave	1 m – 100 m	Multi beam modes Multi Polarization	CSA
4	RISAT	SAR - Microwave	1 m – 50 m	Multi beam modes Multi Polarization	ISRO
5	ResourceSat	AWiFS	56 m	Multispectral	ISRO
6	ResourceSat	LISS-IV MX	5.8 m	Multispectral	ISRO
7	Resourcesat	LISS-III MX	23.5 m	Multispectral	ISRO
8	Cartosat 1	PAN	2.5 m	Panchromatic Stereo	ISRO
9	Cartosat 2, 2A, 2B	PAN	> 1 m	Panchromatic	ISRO

10	Kompsat 2		1 m	Multispectral	KARI
11	Kompsat 3		0.7 m	Multispectral	KARI
12	QuickBird		0.61 m	Panchromatic	DG
13	Pleiades		0.5 m	Multispectral	CNES
14	GeoEye 1		0.41 m	Multispectral	DG
15	WorldView 2		0.46 m	Multispectral	DG
16	WorldView 3		0.31 m	Multispectral	DG
17	Sentinel 1A & 1B		10 m	SAR in VV&VH	ESA
18	Sentinel 2A & 2B		10 m	Multispectral	ESA
19	Cartosat 2D & 2E		0.65m	PAN	ISRO
			2 m	Multispectral	

2.2 Geographic Information System (GIS)

Geographic Information System (GIS) is a computer-based information system used to digitally represent and analyse the geographic features on the earth. Most of the data requirements during a disaster is of spatial nature and need in spatial format for visualisation and decision making. The capabilities of GIS make a very large impact on the planning, mitigation, preparedness and response phases through database integration, organisation, and interfacing with high level programming languages for implementation of geoportals [Bhanumurthy *et al*, 2015]. Geographic Information Systems (GIS) help in analysing the data received by various means in decision making. The technological advancements in the field of computer science, Information Technology (IT) and Open Geospatial Consortium (OGC) standards have significantly changed the GIS, allowing users to take advantage of new distributed mechanism. The OGC is working with an aim to benefit its users by making geographic information and services available to all the people (Perc **Disaster-Specific Tracks in Disaster Management** ivall, 2006). Internet GIS has become an important back bone for disseminating spatial database for disaster managers. In recent years there has been an explosion of mapping applications on the web such as Google Maps and Bing Maps. These websites give the public access to huge amounts of geographic data. Some of them, like Google Maps and Open Layers, expose an Application

Program Interface (API) that enables users to create customized applications. These toolkits offer street maps, aerial imagery, satellite imagery, geocoding, searches, analysis and routing. Web mapping uncovered the potential of crowd sourcing geo-data in projects like OpenStreetMap.

2.3 Mobile Technology and Global Positioning System

Use of mobile and GPS technologies in disaster management should be seen as a new era to aid better management of disaster relief operations due to the leading advances in telecommunication and remote sensing techniques. Mobile technology is helpful in tracking people in disaster prone areas with the help of GPS in mobile phones. Mobile usage has greatly expanded due to 3G, social networking, video, android, *etc.,* which has led to enormous growth in communication and enhanced channels of communication. However, technology has many challenges with respect to network congestion, reliability etc. and there are steps taken to develop global mobile and web disaster portal with the help of cloud computing and interoperability capability for successful management of crisis and disasters on priority basis. The audio-video pictorial representation of mobile features makes the information more informative and rich and can be transferred through the open access communication.

The GPS is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites. GPS has become a widely deployed and useful tool in various fields such as commerce, mobile tracking applications,geo-tagging of location including emergency management and disaster relief operations. This enables visualisation of the facilities in spatial domain and users can build decision support tools so as to locate a particular facility in the area of interest. GPS technology can be integrated with computer technology and it can help in automotive navigation systems. Satellite based communication is quite useful for communicating in the disaster sites for deployment of emergency service functions [Murthi, 2010]. Apart from this, SMS gateway facilitates the entire users for quick actions with SMS alerts.

2.4 Web Technology

The World Wide Web (WWW) is the universe of network-accessible information, an embodiment of human knowledge. The discovery of communication protocol TCP/IP (Transfer control protocol/Internet protocol) gave a new way to communication and acts as basic on which internet works [Tanenbaum, 2010]. Transfer Control Protocol/Internet Protocol is a set of rules that describe how computers can communicate over a network. Web browsers such as Internet Explorer, Google Chrome etc., can run on most operating systems with limited hardware or software requirement. Adobe Flex is another technology often used in Web 2.0 applications. Compared to JavaScript libraries like jQuery, Flex makes it easier for programmers to populate large data grids, charts, and other heavy user interactions. HTML5 offers many new technologies that allow content to be delivered to users in a more streamlined and personalized manner. Web 2.0 sites have started using Javascript/ Ajax framework. There had been a rapid development in field of web. It has its impact in almost every area such as education, research, technology, commerce, marketing, *etc*.

BHUVAN is ISRO's web based utility which allows users to explore thematic maps related to disasters, agriculture, water resources, land cover and also processed satellite data of ISRO (http://bhuvan.nrsc.gov.in/). Bhuvan has enabled Indian government to host public geospatial data as Information layers for visualisation and public consumption. Examples of the types of geospatial layers include Toll Information System for National Highways Authority of India, and Cultural heritage sites for Ministry of Culture. The information for the platform is obtained from the government of India sources or through Crowd Sourcing (https://en.wikipedia.org/wiki/Bhuvan).

3. DECISION SUPPORT TOOLS

Decision support tools consist of appropriate models and domain knowledge and capable of accessing and analyzing dynamic information to generate useful and actionable products such as maps showing area affected and simulated scenarios. Proximity tool provides optimal search of emergency facilities such as hospitals, shelters, rail/bus stations etc. within the user defined distance. From the user input, data search is done in RDBMS to fetch the details of the facility within the buffer area and gives the output in spatial (map) and non-spatial format (tabular). For example, list of hospitals around the flood incident spot can be analyzed around 6kms distance and the list of medical facilities can be extracted using the tool. In emergency situation, disaster manager needs the emergency facilitates for rescue operation in minimum time. For that, shortest/optimal distance between disaster event and facility location has to be analysed at near real time. Network analysis facilitates the user to find out the shortest route between emergency facility and user interested location/disaster site with details of the route. The routing tool finds the shortest way to locate shelters, hospitals etc. with road network data.

3.1 Need for an integrated framework

For enabling the data/information and tools for decision making, a suitable framework needs to be developed using the above technologies with well-defined components for event reporting, real time field information collection, situation assessment, resource identification, resource mobilisation, storing static database, integration of data obtained from multiple sources, communication channel/connectivity for exchange of information, dissemination of information to disaster managers and public. Spatial database is integrated with raster, vector and other ancillary data. Geographic services are developed using standard web GIS development technologies. The geographic data services along with decision support tools are supporting information through a graphical user interface for information in the form of maps, dash boards, alerts, *etc.*

NRSC/ISRO implemented a web portal National database for Emergency Management (NDEM) for Ministry of Home Affairs (MHA). It is a web based geo-spatial national repository of data coupled with a set of decision support tools to assist the disaster managers at various levels in decision making for managing emergency situations. Subsequently, NDEM version 3.0 was launched with latest technologies and additional features like real time communication from the field (Audio video chat), Resource management, Attribute updation of emergency facilities etc Value added products are also hosted on NDEM portal for major disaster events since 2013 onwards.

4. CASE STUDIES

4.1 Flood Hazard Zonation

Flood hazard zonation is one of the most important non-structural measures, facilitating appropriate regulation and development of floodplains and thereby reducing the flood impact. Flood hazard maps are extremely useful for the developing countries where a large proportion of the population live in flood-prone areas [Sanyal & Lu, 2006]. But, a formidable challenge in carrying out realistic assessment of flood hazard zonation and formulation of effective remedial measure is the lack of reliable and up-to-date hydrological database. Prioritizing the flood mitigation activity in areas facing frequent flooding further strengthens the need for identification of spatial extent and temporal pattern of flood-inundated area measures [Jain *et al*, 2005]. The conventional method of preparing flood hazard maps is time consuming, complex and expensive, because of extensive field surveys to be carried out. In this context satellite remote sensing-based approaches offer quick, cost-effective information on the spatial extent of flood inundated areas for different magnitudes of floods and flood mitigation activities [Rao *et al*, 1998; Islam and Sado, 2000c; Liu and Liu, 2002; Manjusree *et al*, 2002; Sanyal and Lu, 2006]. Since the advent of remote sensing technology, satellite images, have become an integral part of flood disaster management activity because of their capability to provide comprehensive, synoptic and multi-temporal coverage of large areas in near real time and at frequent intervals over the flood-affected regions [Roy *et al*, 2008]. Use of multi-temporal satellite images in flood monitoring and management is well documented [Ali *et al*, 1987; Islam and Sado, 2000a; 2000b; 2000c]. By using Analytical Hierarchy Process (AHP) techniques the flood hazard maps can be further refined by combining the satellite derived flood extent and the contributing factors for inundation like elevation, drainage, elevation, slope, landuse and landcover, and soil [Surwase *et al*, 2020].

NRSC (ISRO) prepared flood hazard zonation maps for Assam, Bihar, Odisha, Uttar Pradesh, and West Bengal using the historical spatial flood inundation layers derived from the satellite images acquired during floods. These maps depict the flood vulnerable areas,which are categorized as very high, high, moderate, low and very low. Flood hazard zonation assessment broadly involves the delineation of flood inundation layer, flood inundation frequency computations, estimation of intra-annual flood variations, computation of flood hazard index and integration with administrative boundaries. This analysis helps to compute flood hazard statistics and generation of district-wise flood hazard zonation maps. For Bihar, about 128 historical multi-temporal satellite datasets (1998–2010) were analysed for extraction of flood inundation layer and generation of flood frequency information. In addition, hydrological data (river water level) for 32 gauge stations established on major river systems like Ganga, Kosi, Gandak, Burhi Gandak Bagmati, Kamla Balan and Mahananda for last 13 years was collected from Central Water Commission, and was analysed to derive the intra-annual flood variations and flood hazard index. In Bihar, it is observed that about 26.09% (24.56 lakh ha) of land is affected by flood during 1998-2010 out of the total state geographical area of 94.16 lakh ha. Out of total 24.56 lakh ha of flood affected area, about 0.83 lakh ha of land fall under very high flood hazard category, 1.24 lakh ha under high, about 2.70 lakh ha is under moderate flood hazard category, whereas 5.24 lakh ha under low hazard and about 14.56 lakh ha under very low flood hazard (**Table 4**). It is observed that out of 24.56 lakh ha of the state's flood affected area, about 15.85 lakh ha of the cropped area isvulnerable to flood hazard [Manjusree *et al*, 2015]. The ten districts of Bihar that are flood prone are: Darbhanga, Khagaria, Samastipur, Muzaffarpur, East Champaran, Patna, Madhubani, Saharsa, Bhagalpur and Purnia.

The digital geospatial database generated under the study is uploaded onto Bhuvan ISRO's free web based earth visualization system [Bhuvan, (n.d.)]. Through the portal, policy makers can view flood hazard information spatially in conjunction with transport network, settlements, and district and village boundaries. The portal has a very user-friendly GIS environment that allows the users to obtain information on the flood hazard categories present in a district or village under each category in both spatial and tabular format.

Table 4: Distribution of flood hazard in Bihar state

Hazard Severity	**Flood Hazard Area (ha)**	**Flood hazard % with respect to total geographic area**	**Flood hazard % with respect to total flood hazard area**
Very high	83,280	0.88	3.39
High	1,22,905	1.31	5.00
Moderate	2,70,579	2.87	11.01
Low	5,24,862	5.57	21.36
Very low	14,55,278	15.45	59.23
TOTAL	**24,56,904**	**26.09**	**100.00**

4.2 Utilization of Flood Hazard Information

The digital spatial database on distribution of flood hazard will serve as important baseline information for taking up flood mitigation activities to reduce the losses caused due to floods. This flood hazard information assists policy makers by positioning rescue and relief teams in areas identified as very high to high flood hazard zones during monsoon season for quicker response time for alerting and evacuating people. The planning and development authorities can take appropriate measures to construct or identify suitable number of flood shelters and godowns based on the flood hazard categories. Use of flood tolerant crop varieties in areas more vulnerable to flooding can be promoted by the agriculture department. Preparation of adequate stocks of medicines and mobile medical teams can be kept ready for areas falling under high flood hazard categories to prevent outbreak of epidemics. The Food and Civil supplies departments can maintain sufficient stock of the commodities and store them at appropriate places. In the high flood risk areas, hand pumps can be raised above the high flood level, so as to avoid contamination of water, and houses in the high risk areas can be constructed above the high flood level of previous years. Keeping in mind the flood hazard zonation, administrators can make suitable land use policies.

4.3 Bank Erosion/Deposition-Brahmaputra River, Assam

The Brahmaputra River in Assam is one of the largest alluvial rivers in the world characterized by frequent bank erosion, exceedingly large flow, enormous volume of sediment load, continuous changes in channel morphology, rapid bed aggradations and bank line recession and erosion. According to Assam's Water Resources Department, Assam valley portion of the Brahmaputra has lost approximately 7.4% of its land area due to river bank erosion and channel migration. Using multi-temporal satellite images of 2002 and 2010, the river erosion and deposition pockets were delineated for selected reaches of Brahmaputra River. It is observed that during 2002-2010, the Brahmaputra River has shifted its bank line drastically, causing severe damage to agriculture as well as habitat areas on its both sides. The total land area lost due to erosion has been estimated at 27,098 ha (15,248 ha on the north bank and 11,850 ha on the south bank). On the south bank, the maximum impact of erosion was noticed in the Golaghat district (~3,221 ha), followed by Marigaon (~2,815 ha) and Dibrugarh (~1,442 ha) during the period. On the north bank, Dhubri (~3,030 ha) accounted for maximum area affected by erosion, followed by Sonitpur (~2,823 ha) and Dhemaji (~2,671 ha). Deposition of silt has been very low, compared to the rate of erosion. On the south bank, deposition has been 18% of the total land eroded, while on the north bank it is 24%. Maximum deposition has been observed in Kamrup district (537 ha.) on the south bank and Tinsukia (1,396 ha) on the north bank [Manjusree *et al*, 2013].

Majuli, the largest inhabited river island bounded by the river Subansiri to the north and the mighty Brahmaputra River to the south, is one of the sub-divisions of the Jorhat district, Assam. Erosion of the island is a continuous process and possess a significant concern. The extreme braided nature of the Brahmaputra coupled with silt and sand strata of the banks is the main cause of erosion. Majuli Island is the world's largest river island in the Brahmaputra in Assam and has shrunk as the river surrounding it has grown. From the satellite images, it was observed that the Majuli Island reduced to 44,823 ha in 2010. Erosion in the island was observed due to the shift in Brahmaputra river at Goalgaon and Haldibari. Deposition was observed at Mayadobi mainly due to shift in the river Subansiri besides erosion due to Brahmaputra.

4.4 Shift in the River course-Kosi River, Bihar

The Kosi River has been responsible for some of the most devastating floods in the North Bihar. Also, it is known as the "Sorrow of Bihar" due to the frequent channel migration and the extensive flood damage it causes in the region. During the last two centuries, the Kosi river has shifted its course by about 150 km [Gole and Chitale, 1996; Wells and Dorr, 1987]. The presence of a number of paleo channels all along the surface of Kosi alluvial fan clearly visible on the satellite images, bear testimony to the dynamic nature of the Kosi river. The change in the course of the Kosi River led to a breach in the eastern embankment causing severe floods in parts of North Bihar in 2008.

The analysis of the satellite datasets indicated that the Kosi river course 30 km upstream of the Kosi barrage has been very dynamic and frequently changing its course as observed from the river course delineated for IRS LISS III images of 1997, 2006 and 2011. Due to sedimentation and formation of large sand bar along the main channel, the river flow shifted towards east, at the breach location whereas upstream of it shifted towards west in 2001. The river flow had become almost perpendicular in the months prior to the breach thrusting pressure directly on the eastern embankment. From the satellite images it was observed that the river was flowing very close to the eastern embankment during 2007 and during 2008, the river was observed to be almost abutting the eastern embankment. Measurements made along the river in this stretch showed that the river was flowing at a distance of less than 300 m from the eastern embankment. From the satellite based study, it was observed that the reduction in the cross sectional area of the river and channel carrying capacity due to the sedimentation together with the change in the angle of attack of Kosi river upstream of the breach location prior to the breach, may be one of the causes that led to Kosi river avulsion. The change in the angle of attack upstream of breach location may be a surface manifestation of the sub-surface structural movements. Therefore, flood management of the Kosi river basin requires an integrated approach, which not only considers the hydrological factor, but also the geological and geomorphological aspects of the river basin.

4.5 Urban Flood Modelling

Urban flooding has become a common disaster in the recent times and almost every country is witnessing around the globe. Urban floods are caused by many factors but one of the major factors is the precipitation in a short duration of time means high rainfall intensity. Over the past decades, there have been an increasing number of extreme rainfall and flood events occurring globally due to climate change, which paralyze cities and result in serious social and economic consequences. Numerous challenges are faced by the city civic authorities, planners and policy makers to mitigate the rise in the urban floods. Urban flooding is a result of significant growth in urbanization, encroachment on drains - water bodies, insufficient capacity with poor maintenance of storm water drains, dumping unwanted waste in nalas resulting blockage, improper planning and occupation of low lying areas. Urban population forecast states that 5 billion people will be residing in cities and towns by 2030 and the urban population of Africa and Asia continents will be twice in a single generation [UNFPA, 2007]. As for future projections, a Special Report of the Intergovernmental Panel on Climate Change says that "it is likely that the frequency of heavy precipitation will increase in the 21st century over many areas on the globe", although recent analyses have highlighted fairly large uncertainties and model biases [Field *et al*, 2012]. Some of the major urban flood events, like Mumbai (2005), Hyderabad (2000 and 2016), Chennai (2015) and Bangalore (2016), provoked the National Disaster Management Authority (NDMA), the apex body in India for disaster management to come up with separate guidelines, plans and policies for urban flooding and rural flooding [Bhatt and Rao, 2018]. In India, most of the drainage lines were designed to accommodate 12–20 mm rainfall intensities [NDMA, 2010].

To accurately simulate detailed urban flood propagation and inundation of the ground's surface, coupling of the 1D and 2D hydrodynamic model is necessary to consider flow interactions between underground pipes and the ground's surface. 1D model and 2D model in the coupled model are used to simulate flows in the pipe/river drainage system and surface inundation, respectively. For the representation of the surface flooding depth and simulating flooding in urban areas, new models like PCSWMM (Storm Water Management Model) and MIKE URBAN have been introduced by coupling 1D with 2D flood inundation models [Leandro *et al*, 2009]. Some hydraulic models like HEC-RAS (Hydrologic Engineering Centre River Analysis System) are capable of solving 2D Equation and can be used for urban flooding in the case where flooding is on account of overflowing of streams in the urban areas. The Height Above the Nearest Drainage (HAND) model is a terrain descriptor that calculates the difference in elevation of each pixel and its nearest drainage point [Rennó *et al*, 2008] and normalizes topography according to the local relative heights found along the drainage network which is used. This model was used to find the possible low lying areas or floodplains along the local drainage line. The model has been applied to Amazonia, where it was calibrated and validated by establishing a relationship between soil water conditions and drainage potential [Rennó *et al*, 2008; Nobre *et al*, 2011; Cuartas *et al*, 2012]. HAND was used to derive a high-resolution flood map for the entire USA [Liu *et al*, 2016]. In Southern Brazil, HAND has been applied as a tool for flood mapping [Nobre *et al*, 2015]. The HAND model was found to have low sensitivity to the DEM resolution – no major disparity was observed for different DEM resolutions, but results may vary depending on the source of the selected DEM [Gustavo *et al*, 2018]. It has potential applications in Surface hydrology, Meteorology, Land-use, Hazard and Risk assessment and its application provides the possibility of capturing and examining heterogeneities in local environments in a quantitative and widely comparable manner [Noble *et al*, 2011]. This information coupled with forecasts of rainfall based on weather radar and global ensemble predictions can provide a digital overview of the risks associated with the potential urban flood disaster.

The nature or occurrence of flooding in Hyderabad city is due to high intensity rainfall, adequate drainage (open channels) capacities, occupation of low lying areas and blockage in drains, overflowing of nalas (natural drains) and overflowing of lakes & manholes. It can alsobe called as hybrid type flooding and thus modeling urban floods is a complex task. Hyderabad experienced flooding in the year 2001, 2003, 2008, 2016, 2017 and flooded low lying areas. In this study, low lying flood vulnerable areas of Hyderabad city were predicted using HAND model coupled with geospatial approach. Due to non-availability of high resolution DEM, the study is carried out with CARTOSAT satellite derived DEM of 10 meters resolution with vertical accuracy of 1-2 meters. Details of few localities are given in **Table 5**. These hotspots were generated for administrative circles and were deployed at the disaster control room of Greater Hyderabad Municipal Corporation (GHMC) before the starting of 2019 monsoon season. These maps helped the city civic body; Directorate of Enforcement Vigilance & Disaster Management (EVDM) to take emergency actions and alternate plans during the floods reported in September 2019. Further, these maps were validated with ground reported flood localities. About ninety-five percent of localities matched with the model derived vulnerable localities. Furthermore, the maps can be utilized to plan measures like construction of underground artificial storage tanks of a design capacity in the hotspots or pump out water using generators or alternate diversion of flood water for mitigation. They can also be used for diverting traffic at any instant of time.

Table 5: Low-lying vulnerable locations under GHMC

S. No.	**Name of the Circle**	**Localities**
1	Qutubullapur	Chintal, Marrinarayan Reddy Nagar, Venkanna Hills, Manikya Nagar, Surya Nagar and Green Park
2	Kukatpally	Allwyn Colony, Navodaya Colony, Ramnaresh Colony, Vasant Nagar, Aditya Nagar, Smatha Nagar, Saptagiri Colony, Raju Colony, Swamadham Nagar
3	Moosapet	Vivekanand Nagar, Gayatri Nagar, Bhavani Nagar, Khaitalpur, Rana Pratap Nagar, Ramarao Nagar, KPHB phase 2 and 3
4	Alwal	Bodevi Nagar, Chandra Nagar Colony, Saraswati Colony, Janaki Nagar, Dinakar Nagar, Subhodaya Nagar, Chitamma Nagar Colony, Bhudevi Nagar, Padmavati Colony, Subhash Nagar, Vedvihar AWHO, RTC Officers Colony
6	Musheerabad	Gandhi Nagar, Necklace Rotary, Indira Park, Azambad Junction, Busbhavan, Padma Colony and Adikmet
6	Amberpet	Ramkrishna Nagar, Akash Nagar, Police Colony, Qadri Bagh, Nehru Nagar, Rathna Nagar, Kutbiguda, Zindatilismath Nagar, Street No.9 Himayath Nagar, Chikadpally Market, Tilaknagar Roadway
7	Secunderabad	Alluggadda Bavi, Mettuguda, Namala Gundu, Hanuman Nagar Colony, Lalaguda North, Bouddha Nagar, Manikeshwari Nagar, Lalitha Nagar, Warasiguda

8	Malkagiri	Raghavendra Colony, Santosh Nagar, Venkateshwara Colony, Deendayal Nagar, Sai Ram Nagar, Ganesh Nagar, Tirumala Nagar, Mirzalguda, Fatehnagar, Railway Colony, Satya Reddy Colony, R. K. Nagar
9	Begumpet	HPS, Shyamlal Nala, Prakash Nagar, NTR SP Road, Baharani Complex, KIMS Hospital, Anand Theatre SP Road, Brahamanwadi, Umanagar, M.G.Road, Praga Tools
10	Charminar	Museum Road, Nayapul, City College, Engine Bowli, Hussain Alam, Ghansi Bazaar, Bibi Bazaar

5. CONCLUSION

In this paper, various spatial technologies and their potential role for generation of flood inundation information, preparation of flood hazard zones, riverbank erosion and changes in the river course, urban flooding were discussed along with the case studies. The historical flood inundation layers from the past 20 years derived from multi-temporal satellite data have a potential role in understanding the geomorphic nature of flooding and design mitigation processes accordingly. Satellite derived flood hazard information serves as an important baseline information for prioritizing flood affected areas for taking up flood mitigation measures and assist in taking flood insurance schemes. Further, availability of the spatial information on web geo-portals would assist the decision makers to plan the floodplain protection works in order to reduce the flood damages. Information on changes in the river course, bank erosion and deposition will help the planners for taking measures for channel stabilization, identification of vulnerable embankments and strengthening of embankments, design bank protection works. This will help in reducing the susceptibility to breaches and minimise bank erosion thereby reduce the damages. Similarly, vulnerable flood city maps will help civic administration authorities for preparedness thereby reducing the damages.

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References

1. Ali,A., Quadir,D.A., and Huh,O.K., (1987), "Agricultural, hydrologic and oceanographic studies in Bangladesh with NOAA AVHRR data," **International Journal of Remote Sensing**, 8 (6), 917–25
2. Bhatt,C.M., Rao,G.S., Manjushree,P. and Bhanumurthy,V. (2010), "Space Based Disaster Management of 2008 Kosi Floods, North Bihar, India," **Journal of Indian Society of Remote Sensing**, 38 (1), 99–108, DOI: 10.1007/s12524-010-0015-94
3. Bhatt,C.M., Rao,G.S., Manjushree,P., and Bhanumurthy,V., (2011), "Potential of High Resolution Satellite Data for Disaster Management: A Case Study of Leh, Jammu & Kashmir (India) Flash Floods, 2010", **Journal of Geomatics Natural Hazards and Risks**, 2(4):365-375, http://doi/abs/10.1080/19475705.2011.580014 5.
4. Bhatt,C.M., Rao,G.S., Farooq,M., Manjusree,P., Shukla,A., Sharma,S.V.S.P., Kulkarni,S.S., Begum,A., Bhanumurthy,V., Diwakar,P.G., and Dadhwal,V.K., (2016), "Satellite Based Assessment of the Catastrophic Jhelum Floods of September 2014, Jammu & Kashmir, India", **Journal of Geomatics Natural Hazards and Risks**, http://dx.doi.org/10.1080/19475705.2016.1218943
5. Bhanumurthy,V., Shankar,G.J., Rao,K.R.M., Nagamani,P.V., (2015), "Defining a framework for integration of geospatial technologies for emergency management," **Geocarto International**, 30(9), pp 963-983.doi 10.1080/10106049.2015.1004132
6. Bhuvan, (n.d.), Disaster Services (NDEM public)

   http://bhuvan-noeda.nrsc.gov.in/ disaster/disaster/disaster.php (A Accessed 15 September 2020
7. Clark,M.J., (1998), "Putting water in its place: A perspective on GIS in hydrology and water management," **Hydrological Processes**, 12, 823–834, doi: 10.1002/(SICI)1099-1085 (199805) 12:6 <823:AID-HYP656>3.0.CO;2-ZView/save citation

8. Bhatt,C.M., Rao,G.S., Manjusree,P., and Bhanumurthy,V., "Remote Sensing and GIS Technology for Flood Monitoring and Management," *Sustainable Holistic Water Resources Management in a Changing Climate*, Jain Brothers, New Delhi, ISBN: 978-81-8360-253-2

9. Cuartas,L.A., Javier Tomasella., Antonio DonatoNobre., Carlos Afonso Nobre., Martin G.Hodnett., Maarten J.Waterloo., Sylvia Mota de Oliveira., Rita de Cássia vonRandow., RalphTrancoso., MônicaFerreira (2012), "Distributed hydrological modeling of a micro-scale rainforest watershed in Amazonia: Model evaluation and advances in calibration using the new HAND terrain model," **Journal of Hydrology**, 462-463, 15– 27. doi:10.1016/j.jhydrol.2011.12.047

10. CWC, (2020a), State-wise Flood Data Damage Statistics, Central Water Commission, http://cwc.gov.in/sites/default/files/statewiseflooddatadamagestatistics.pdf

    Accessed on 2.09.2020

11. CWC, (2020b), State-wise Flood Data Damage Statistics, Central Water Commission, http://cwc.gov.in/sites/default/files/Handbook-05-Jun-12_0.pdf

    Accessed on 14.09.2020

12. Elliott,A.H., and Trowsdale,S.A., (2007), "A review of models for low impact urban stormwater drainage," Environmental Modelling and Software, 22, 394–405

13. Field,C.B., Barros,V., Stocker,T.F., Qin,D., Dokken,D.J., Ebi,K.L., Mastrandrea,M.D., Mach,K.J., Plattner,G.K., Allen,S.K., Tignor.M., Midgley,P.M (2012), "Managing the risks of extreme events and disasters to advance climate change adaptation," A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, and New York, NY, USA

14. Gharari,S., Hrachowitz,M., Fenicia,F., Savenije,H,H,G.,(2011), "Hydrological landscape classification: investigating the performance of HAND based landscape classifications in a central European meso-scale catchment," **Hydrology and Earth System Sciences**, 15, 3291. doi:10.5194/hess-15-3275-2011

15. Gole,C.V., and Chitale,S.V., (1996), "Inland delta building activity of Kosi river," **Journal of the Hydraulics Division**, American Society of Civil Engineers, 92, 111-126

16. Speckhann,G.A., Luiz,P., Chaffe,B., Goerl,R.,F., Josina de Abreu,J., Antonio,J., and Flores,A., (2018), "Flood hazard mapping in Southern Brazil: a combination of flow frequency analysis and the HAND

model," **Hydrological Sciences Journal***,* 63(1), 87-100, DOI: 10.1080/02626667.2017.1409896

17. Habersack,H., Haspel,D., and Schober,B., (2015) "Flood prevention and mitigation at large rivers," **Natural Hazards**, 75, 1–3, https://doi.org/10.1007/s11069-014-1347-5
18. Islam,M.M., and Sado,K., (2000a), "Development of flood hazard maps of Bangladesh using NOAA-AVHRR images with GIS," **Hydrological Sciences Journal**, 45 (3), 337–55
19. Islam,M.M., and Sado,K., (2000b), "Flood hazard assessment in Bangladesh using NOAA AVHRR data with geographical information system," **Hydrological Processes**, 14(3), 605–20
20. Islam,M.M., and Sado,K.,(2000c), "Satellite remote sensing data analysis for flood damaged zoning with GIS for flood management," **Journal of Hydraulic Engineering**, 44, 301–6
21. Jain,S.K., Singh,R.D., Jain,M.K., and Lohani,A.K., (2005), "Delineation of flood prone areas using remote sensing techniques," **Journal of Water Resources Management**, 19 (4), 333–47
22. Jayaraman,V., Chandrasekhar,M.G., and Rao,U.R., (1997), "Managing the Natural Disasters from Space Technology Inputs," **Acta Astronautica**, 40 (2-8): 291-325
23. Leandro,J., Djordjević,S., Chen,A.S. and Savić,D.A., (2009), "Comparison of 1D/1D and 1D/2D coupled (sewer/surface) hydraulic models for urban flood simulation," **Journal of Hydraulic Engineering**, 135(6), 495-504
24. Liu,R., and Liu,N., (2002), "Flood area and damage estimation in Zhejiang, China," **Journal of Environmental Management**, 66(1), 1–8
25. Liu,Y.Y., David Maidment., David G. Tarboton., Xing Zheng., Ahmet Yildirim.,Nazmus S. Sazib., and Shaowen Wang (2016), "A CyberGIS approach to generating high-resolution height above nearest drainage (HAND) raster for national flood mapping," CyberGIS 16, *The Third International Conference on CyberGIS and Geospatial Data Science*, 24-26 July 2016, Urbana, Illinois, USA, 1–6
26. Manjusree,P., Satyanarayana,P., Bhatt,C.M., Sharma,S.V.S.P., and Rao,G.S., (2013). "Remote Sensing and GIS for River Morphology Studies - National Natural Resources Management System, **Bulletin NNRMS(B),** 18, December 2013
27. Manjusree,P., Bhatt,C.M., Begum,A., Rao,G.S., and Bhanumurthy,V., (2014), "A decadal historical satellite data analysis for flood hazard evaluation: A case study of Bihar (North India), **Singapore Journal of Tropical Geography**, 36, 308-323, doi.org/10.1111/sjtg.12126

28. Manjusree,P, Bhanumurthy,V, and Rao,G.S., (2002), "Planning and monitoring of flood control measures using satellite remote sensing," ISPRS Commission VII WGVII/5.1 **Symposium on Resource and Environmental Monitoring**, 3–6 December 2002, Hyderabad

29. Murthi,K.R., Sridhara,A., Bhaskaranarayana, and Madhusudana,H.N., (2010), "New developments in Indian space policies and programmes — The next five years," **Acta Astronautica**, 66.3: 333-340.

30. Nijzink, Remko C.; Samaniego, Luis; Mai, Juliane; Kumar, Rohini; Thober, Stephan; Zink, Matthias; Schäfer, David; Savenije, Hubert H. G.; Hrachowitz, Markus (2016), "The importance of topography-controlled sub-grid process heterogeneity and semi-quantitative prior constraints in distributed hydrological models," **Hydrology and Earth System Sciences**, 20, 1151–1176. doi:10.5194/hess-20-1151-2016

30. Neelz,S., and Pender,G., (2009), "Desktop review of 2D hydraulic modelling packages," **Environmental Agency**, Bristol

31. Antonio Donato Nobre., Luz Adriana Cuartas., Marcos Rodrigo Momo., Dirceu Luís Severo., Adilson Pinheiro., Carlos Afonso Nobre,, (2015), "HAND contour: a New Proxy Predictor of Inundation Extent," **Hydrological Processes**, 30, 320–333. doi:10.1002/hyp.10581

32. NRSA, (2020), Webpage on Disasters, National Remote Sensing Center, Hyderabad bhuvan.nrsc.gov.in/disaster (Accessed on 2.09.2020)

33. Manjusree,P., Kumar,L.P. Bhatt,C.M., Rao,G.S. and Bhanumurthy,V., (2012), "Optimization of Threshold Ranges for Rapid Flood Inundation Mapping by Evaluating Backscatter Profiles of High Incidence Angle SAR Images," **International Journal Disaster Risk Science**, Vol. 3, No. 2

34. Percivall,G., and Reed,C., (2006), "OGC sensor web enablement standards," **Sensors & Transducers Journal**, 71 (9), 698-706

35. Rao,D.P., Bhanumurthy,V, Rao,G.S., and Manjusri,P., (1998), "Remote Sensing and GIS in Flood Management in India," **Memoir Geological Society of India**, 41, 195–218

36. Camilo Daleles Renno.,Antonio DonatoNobre., Luz AdrianaCuartas., João Vianei Soares., Martin G.Hodnett., Javier Tomasella., Maarten J.Waterloo (2008), "HAND, a new terrain descriptor using SRTM-DEM: mapping terra-firme rainforest environments in Amazonia," **Remote Sensing of Environment**, 112, 3469–3481, doi: 10.1016/j.rse.2008.03.018

37. Rossman,L.A., (2010), "Storm Water Management Model," User's Manual, Version 5.0. Cincinnati, OH,

38. Roy,P.S., Bhanumurthy,V., Murthy,C.S., and Chand,T.K., (2008), "Space for disaster management: lessons and perspectives," **Journal of South Asia**

Disaster Studies, 1(1), 157–77,

http://saarcsdmc.nic.in/pdf/publications/journal/chapter-9.pdf

39. Sanyal,J., and Lu,X.X., (2006), "GIS based flood hazard mapping at different administrative scales: A case study in Gangetic West Bengal, India," **Journal of Tropical Geography**, 27(2), 207220. doi.org/10.1111/j.1467-9493.2006. 00254.x
40. Tanenbaum,A., (2010), *Computer Networks*, Prentice Hall. ISBN 978-01321-26953
41. Surwase,T., Manjusree,P., Nagamani,P.V., and Jaisankar,G., (2019), "Novel technique for developing Flood Hazard Map by using AHP - A study of part of Mahanadi River in Odisha," **SN Applied Sciences**, October 2019, 1:1196,14
42. UNFPA, (20070, "State of World population 2007," *Unleashing the potential of Urban Growths I*, *UNFPA*
43. UNDESAD, (2012), *World Urbanization Prospects: The 2011 Revision*, United Nations Department of Economic and Social Affairs, Population Division, New York
44. Wells,N.A., and Dorr,J.A., (1987), "Shifting of Kosi River, Northern India," **Geology**, 15, 204-207
45. Zoppou,C., (2001), "Review of urban storm water models," **Environmental Modelling and Software**, 16, 195–231

R. Pradeep Kumar & C. V. R. Murty

Protecting the Built Environment from Earthquakes

Abstract: Earthquakes cause disasters only when the built environment fails to resist the earthquake shaking experienced in the affected area, thereby causing losses of life and property. Ensuring structural safety of the built environment alone will result in earthquake safety of India. India needs sufficient number of competent structural, geotechnical engineers and architects to design and construct its new earthquake resistant buildings and facilities and to retrofit its existing ones. This paper urges quantum changes in the educational, social, technical, financial, techno-legal, industrial and administrative governance systems of the country, and re-iterates the stand of the nation of zero tolerance to avoidable deaths due to earthquakes.

Key words: Mitigation, Technical Competence, Retrofitting, Safety Audit, Regulatory System

1. INTRODUCTION

In the last 3 decades, India has seen at least 10 earthquakes that caused losses and damages. And, the story of earthquakes together is dramatic – ~50,000 human lives lost, ~5,00,000 humans injured, ~10,00,000 houses collapsed and ~50,00,000 houses damaged [Sebeer *et al*, 1993; Jain *et al*, 1994; Jain *et al*, 1997; Jain *et al*, 1999; Jain *et al*, 2001; Jain *et al*, 2005; Murty and Rai, 2005; Murty, 2007; Murty *et a*l, 2011; Murty *et al*, 2012]. But, one item is common to all earthquakes – this huge loss of lives is attributable completely to collapse of the physical built environment. Even today, the large stock of buildings and structures standing has high vulnerability of earthquake ground shaking. The reasons for this are:

(a) Lack of competent technical human resources, and

(b) Absence of systems and processes which overlooks the addition of more vulnerable buildings and structures.

About $4/5^{th}$ of the built environment is in Seismic Zones III, IV and V (moderate to severe earthquake shaking areas), even though only about 57% land area falls in these zones [BMTPC, 2017]; therefore, about 100 Crores of people are at risk. Of the three contributors to risk: (a) **Hazard** needs to be estimated as accurately as possible, and earth scientists are the best set to provide this accuracy; (b) **Vulnerability** needs to be reduced, and engineers and architects are best suited to do this, and (c) **Exposure** needs to be limited, and the municipal authorities are best placed to guard this by not unduly increasing the FAR.

Earthquake safety of India can be ensured by:

(a) *People* – long-term investment to create a large pool of technical competent engineers, architects and artisans;

(b) *Processes* – urgent action to put in place systems and procedures that address and guarantee earthquake safety of the built environment; and

(c) *Products* - programmed action to ensure that every new structure built is earthquake-resistant and to replacing vulnerable buildings and structures, at least those of high priority to begin with.

To make the above happen, a whole ecosystem of earthquake safety is required. This paper elaborates on the activities, initiatives, programs and structural changes necessary to make *Earthquake Disaster Management (EDM)* effective – a litmus test for *EDM* is the number of buildings and structures that collapse in the next damaging earthquake of MSK intensity VII or higher.

2. EARTHQUAKE SAFETY OF INDIA

The matter of **earthquake safety is a structural safety**

(technology) matter – a matter of civil engineering and architecture to begin with. Thus, in addition to the DM Act, 2005 [DMA, 2005], DM Policy [DMP, 2009] and DM Plan [DMP, 2019], the *National Disaster Management Guidelines* on *Management of Earthquakes* [NDMG-ME, 2007] seeks through its Vision, *"Zero Tolerance to Avoidable Deaths due to Earthquakes."* Hence, all efforts should be made to reduce the collapse of buildings and structures during earthquakes. And so, if collapses of buildings and structures are avoided during earthquakes, the earthquake disaster would be eliminated. In this regard, the NDMA published the following documents:

(1) Guidelines for banks and lending institutions to make loans contingent on compliance of Disaster Resilience Standards [NDMG-BLI, 2010];

(2) Guidelines for Seismic Retrofitting of Deficient Buildings and Structures [NDMG-SR, 2014];

(3) Guidelines for Hospital Safety [NDMG-HS, 2016] to make all hospitals in India to be structurally and functionally safer from disasters;

(4) Guidelines for School Safety [NDMG-SS, 2016] to make all children and their teachers, and other stakeholders in the school community safe from any kind of preventable risks due to natural hazards that may threaten their well-being during the pursuit of education;

(5) Home Owner's Guide for Earthquake and Cyclone Safety [NDMA, 2019a], to guide those who wish to construct a house, and buy a house or a flat in a multi-storey building; and

(6) Earthquake Disaster Risk Index Report [NDMA, 2019b] to forecast the relative earthquake risk within a city and across cities.

(7) A Primer on Rapid Visual Screening (RVS) – Consolidating Earthquake Safety Assessment Efforts in India [NDMA, 2020] to forecast the relative earthquake risk within a city and across cities.

On the capacity development side, the *Ministry of Home Affairs, Government of India*, conducted two national programs NPCBAERM and NPCBEERM for Architects and Engineers, respectively, during 2004-2006. Alongside, the Ministry of Human Resource Development conducted another National Program NPEEE during 2003-2007 for capacity development of technical institutions and enhancing facilities therein. But, there was no follow up program after these initiatives organized in the aftermath of the 2001 Bhuj Earthquake. Towards capturing and documenting perishable lessons from earthquakes, the NDMA constituted Post-Earthquake Reconnaissance Teams after the 2011 Sikkim, 2013 Doda, 2015 Nepal and 2016 Manipur earthquakes. But, the R&D Institutes did not capitalize on these post-earthquake reconnaissance studies to undertake detailed follow up studies. These discrete products and initiatives did not mange to create a momentum to gather the needed technical human resources and to establish the systems and processes. Earthquake disaster mitigation in India is waiting at the starting blocks.

3. EARTHQUAKE DISASTER MANAGEMENT

Disaster Management (DM) hinges on six aspects in the cycle of each hazard, namely *Prevention*, *Mitigation* and *Preparedness* before the event, and *Response*, *Rehabilitation* and *Reconstruction* after the event. Because earthquakes are natural events, *Prevention* is not in focus in *Earthquake DM (EDM)*, even though *earthquake forecasting* has been attempted for a century with rare success. Thus, only 5 aspects are in focus in EDM, namely *Mitigation*, *Preparedness*, *Response*, *Rehabilitation* and *Reconstruction*; these 5 aspects are inter-related (**Table 1**). The elements on the diagonal boxes of the table are the main thrusts of EDM, namely:

(1) **Safe Constructions**: Focus should be on ensuring that all *new constructions* are earthquake resistant and *existing constructions* are retrofitted to become earthquake resistant;

(2) **DM Plans**: *EDM Plans* are different for national, state, district and town levels across the country. And, Plans at each level should flow from the plan at the next higher level;

(3) **Search & Rescue**: The emergency period of Earthquake Response is dominated by the effort to identify and save

survivors trapped under the rubble of collapsed structures;

(4) **Livelihood Restoration**: Re-starting economic activities at the earliest opportunity is critical after the earthquake emergency is over; and

(5) **Built Environment Restoration**: Providing all persons who lost their houses during the earthquake to have their own roofs, and restoring all civic infrastructure are signs of restoring normalcy to the affected community.

And, the elements in the off-diagonal boxes are the minimum mandatory actions that should be undertaken to work towards establishing earthquake safety in India.

Table 1: Inter-related elements in the five aspects of *Earthquake Disaster Management*

Aspects	Mitigation	Preparedness	Response	Rehabilitation	Reconstruction
Mitigation	**Safe Constructions**	Technical Education	Damage Assessment	Temporary Shelters	Permanent Shelters
Preparedness		**DM Plans**	Active EOCs & Mock Drills	Community Engagement	Owner Driven Reconstruction
Response			**Search & Rescue**	Trauma Counselling	In-situ or Relocate
Rehabilitation				**Livelihood Restoration**	Loss Compensation
Reconstruction					**Built Environment Restoration**

3.1 Earthquake Mitigation

Earthquake Disaster Mitigation hinges on 5 aspects, namely *Typology*, *Education*, *Safety*, *Practice* and Policy; these aspects are inter-related (**Table 2**). The elements on the diagonal boxes of the table are critical to Earthquake Disaster Mitigation, namely:

(1) **Typologies of Structures**: Documenting typologies of different structures built is critical, because it will help in understanding their earthquake resistance, options to retrofit existing structures (where required) and improvements needed to make new structures earthquake resistant. For example, India

has about 30 broad typologies of houses. Only a few of them are safe, namely the traditional typologies built over centuries along the Himalayas. But, these 30 odd typologies have not been studied quantitatively through experimental studies on full-scale houses and associated analytical studies. A long-term program is required to study and set standards for the complete set of typologies adopted in the construction of buildings and structures across the geographical spread of India, especially *material preferences* and *design requirements*.

(2) **Technical Education**: Technical education pertaining to earthquake safety is a serious concern in India. Attention is fading from fundamental aspects that ensure holistic safety of structures, and moving to new technologies that provide speed and economy. Also, hands-on laboratory experience is diminishing owing to lack of resources to maintain and run teaching laboratories. Currently, at the undergraduate level, only 7 government colleges in the State of Gujarat have earthquake safety as mandatory part of the civil engineering curriculum. With about 82% of the people if India (about 100 Crores) living in seismic zones III, IV and V, the subject of earthquake safety should find place in the mandatory part of civil engineering and architecture education.

(3) **Full Scale Testing**: Earthquake resistant constructions do undergo damage when shaken by earthquakes that produce large intensities of ground expected at the site. It remains to be examined if the said damage is life threatening in a given typology of the structure. Only full-scale testing can demonstrate quantitatively the likely damage in such situations. Currently, India has two facilities existing in the country for testing full-scale buildings (up to 3 storeys) and bridge piers (up to 10 m height). To cater to the needs of 100 Crore people living in moderate-to-severe seismic zones, more full-scale testing facilities need to be established, at least region-wise to begin with, towards making testing affordable and equitable. A multi-agency collaborative project is required to undertake full-scale earthquake testing of structures, so that eventually all

buildings and structures of different typologies adopted in the country are evaluated.

(4) **Safety Standards**: India had a separate standard (IS 1893) for earthquake resistant design of structures from the early 60s. But, this standard was revised after long periods of time, especially during 1980s to 2015. Many provisions need to be updated. Internationally, such important standards are revised once in 3 years. Also, new standards need to be authored pertaining to earthquake safety of the built environment. For instance, an Indian Standard is not available for earthquake safety of coastal structures. Preparation of earthquake safety standard based on R&D work in the country should be taken up as a national mission for academia, R&D organizations and Industries to meet in the next 5 years; and

(5) **Structural Safety Act**: Structural safety compliance of all new constructions cannot continue with the IIT-NIT approval system, as is the current practice in most government projects. India should move to a more sustainable peer review approach in the matter of structural safety. A strong Structural Safety Act is required to set right many aspects of how structural safety is addressed in India, especially earthquake safety. Urban Local Bodies, Municipalities and Panchayats should put in place systems and processes for a Third Party Peer Review of the Structural Safety of all new constructions and retrofit of existing structures. Urgently, India should strengthen existing Laws and their implementation, or have a new Structural Safety Act. It should resolve all contentious issues, including: (i) competency based structural safety related services to be provided by civil engineers and architects, and (ii) professional consulting services related to peer-review, proof check, field tests, etc.

And, the elements in the off-diagonal boxes are the minimum mandatory actions that should be undertaken to work towards establishing earthquake safety in India.

Table 2: Inter-related elements in the five aspects of *Earthquake Disaster Mitigation*

Aspects	**Topology**	**Education**	**Safety**	**Practice**	**Policy**
Topology	**Typologies of Structures**	Manuals of Good Practice	Regulate Unsafe Typologies	Skilled Artisans	Change Bye-laws
Education		**Technical Education**	New technology	Continuing Education	Licensing of Engineers
Safety			**Full Scale Testing**	Retrofitting	Peer Review
Practice				**Safety Standards**	Risk Indexing
Policy					**Structural Safety Act**

3.2 Earthquake Preparedness

Earthquake Disaster Preparedness hinges on 5 aspects, namely *Content*, *Sensitization*, *Facilities*, *People* and *Systems*; these aspects are inter-related (**Table 3**). The elements on the diagonal boxes of the table are critical to Earthquake Disaster Preparedness, namely:

(1) **Mass Media Communication Material**: DM is every citizen's subject. Disasters can be managed better with improved awareness and preparation by each citizen. Hence, impact of disasters, ways of mitigating their negative consequences, role of each citizen, and benefits of undertaking mitigation measures needs to be showcased to the nation. Content should be carefully prepared to suit different target audiences in different languages. And, a comprehensive mass media campaign should be launched;

(2) **Risk Communication**: Communicating facts to the citizens based on quantitative projections derived from risk assessments exercises related to each hazard are precursors to allocation of resources and focused efforts by governments. Currently, assessment of risk is in the nascent stages in India. But, a start should be made, even though imperfect; it will evolve with increase in competence and experience. The method of

assessing risk should be updated continually and the revised numbers projected. But, communicating risk should be with a focused goal of achieving a predetermined change. Scales of assessing risk should be start from local level and grow to region and national levels. Changes are easy to bring about immediately after the earthquake; it is prudent to be ready ever with risk communication content and plans;

(3) **Emergency Operations Center**: Emergency Operations Center (EOC) plays a crucial role in DM. All operations required to be performed in the golden hour should be rehearsed in peace time by communicating social events like seasonal large scale festivities of the village or town. Good forecasting of the likely disaster is the key to making EOCs successful. They should be equipped with state-of-the art facilities and manned by competent manpower. SDMAs should ensure that the State EOC as well as the District EOCs are established and functional fully immediately;

(4) **Mock Drills**: An effective way of helping each citizen internalize DM is by performing Mock Drills at regular intervals in all academic institutes, housing colonies, and offices. This is a centerpiece of DM planning. This could be done at predetermined days of the year, at least one in a quarter, and on a surprise date in a year. Mock drills help understand reaction time and shortcomings in the preparedness; and

(5) **Active SDMAs and DDMAs**: The key to DM Preparedness is a vibrant SDMA, which will motivate and inspire the DDMA to become action centers. Seamless, goal-driven partnerships are needed between NDMA and SDMAs, and between SDMAs and DDMAs. The success of DDMAs will depend on how well they partner with local NGOs and voluntary groups in implementation of the DM plans.

And, the elements in the off-diagonal boxes are the minimum mandatory actions that should be undertaken to work towards establishing earthquake safety in India.

Table 3: Inter-related elements in the five aspects of *Earthquake Disaster Preparedness*

Aspects	Sensitization	Content	Facilities	People	Systems
Sensitization	**Risk Communi_ cation**	Risk Index	DM Plans	Media Linkage	Policy Makers
Content		**Mass Media Communi_ cation Material**	Print, Audio and Video Documents	Media Campaign & Events	Public Awareness
Facilities			**Emergency Operations Centers**	Disaster Response Network	Stockpile Rescue Facilities
People				**Mock Drills**	Chain of Command
Systems					**SDMAs and DDMAs**

3.3 Earthquake Response

Earthquake Disaster Response hinges on 5 aspects, namely *Systems*, *Emergency*, *Logistics*, *Medical Response* and *Community*; these aspects are inter-related (**Table 4**). The elements on the diagonal boxes of the table are critical to Earthquake Disaster Response, namely:

(1) **Emergency Operations Centers**: EOCs that have rehearsed adequately during *DM Preparedness* will become the nerve centers during *DM Response*. Because EOCs serve these two major aspects of DM, EOCs should be up and running immediately;

(2) **Search & Rescue**: Saving the people alive and trapped under the rubble of collapsed buildings and structures is a scientific activity. S&R Teams should have knowledge of structural engineering, orthopedics and robotics to undertake the task. They should be trained on judging when to intervene in person and when to access through robots. Well trained SDRFs will be of high value, which are propositioned in strategic locations of each state.

(3) **Civil Supplies**: Earthquakes can severely impair transportation system, and providing civil supplies in such a situation can be a

challenge. To ensure at least basic supply of essential items in the aftermath of damaging earthquakes, communities need to be sensitized on the need to have emergency supplies (for a week at least) of essentials, which include medical items, food and water, along with other useful items like footwear and torchlight.

(4) **Triage**: With injured patients at emergency at a hospital, prioritizing which condition (cardiac, orthopedic, surgery or trauma) of the patient needs first decision making. Triage is vital here to determine the order in which the ailments will be treated. Emergency bays of hospitals should practice triage in their normal functioning. Training of personnel, especially the non-medical support staff, is vital; and

(5) **Golden Hour Response**: Generally, about 72 hours after an earthquake event are crucial. The chances of survival can be increased substantially, if the injured can be given timely and appropriate support. Also, affected persons need to be given care and personal counseling. Communities need regular and accurate updates.

And, the elements in the off-diagonal boxes are the minimum mandatory actions that should be undertaken to work towards establishing earthquake safety in India.

Table 4: Inter-related elements in the five aspects of *Earthquake Disaster Response*

Aspects	**Systems**	**Emergency**	**Logistics**	**Medical Response**	**Community**
Systems	**Emergency Operations Centers**	Disaster Response Force	Standard Operating Procedures	Infrastructure	Information Dissemination
Emergency		**Search & Rescue**	Incident Command Sys.	Paramedics	Community Responders
Logistics			**Civil Supplies**	Equipment & Manpower	NGO Coordination Center
Medical Response				**Triage**	SH groups (Red Cross Trained)
Community					**Golden Hour Response**

3.4 Earthquake Rehabilitation

Earthquake Disaster Rehabilitation hinges on 5 aspects, namely *Compensation*, *Temporary Shelters*, *Psycho-Social Trauma*, *Livelihood* and *Community*; these aspects are inter-related (**Table 5**). The elements on the diagonal boxes of the table are critical to Earthquake Disaster Rehabilitation, namely:

(1) **Ex-Gratia**: Rehabilitation after an Earthquake is complex task and it needs a comprehensive and collective effort. Giving Ex-gratia (given out of empathy to fellow human beings though not as compensation) to kith-kin of persons dead during the earthquake helps the poor. But, this is only a starting point of Rehabilitation process in DM;

(2) **Health Standards**: Temporary Shelters provided should meet the WHO standards laid down to ensure basic hygiene and prevent additional challenges arising out of lack of cleanliness and medical safety;

(3) **Medical Support**: While rehabilitating affected persons after earthquakes, their past medical record should be considered. Often, such medical records are not available. Hence, only experienced doctors should give personalized solutions. Such a system needs to be developed over a period of time. Standard operating procedures should be developed by foreseeing the post-earthquake situation. A review of the current medical practices and facilities is necessary, to plan how this medical system will service the sudden spike in the medical support needed;

(4) **Economic Activities**: After an earthquake, all employment activities are expected to be stalled for some time. The most crucial element of rehabilitation after an earthquake is restoring economic activity. The affected people feel reassured that they can rebuild their lives if their employment is restored. The ensuring minimum wages is essential for unskilled workers. Bringing skilled men/women back to their regular economic activities at the earliest opportune time is a central part of the rehabilitating communities; and

(5) **Social Activities**: While disaster recovery is a time consuming process, the engagement with the community should start as soon as possible; it gives hope and strength to people and helps them come back to normal condition. For this to happen, planned social engagements can be helpful. Communities should be encouraged to have religious congregations, mass prayers, festivals, etc. This will help in re-establishing the human bonds within the community, and recovery can be made smoother.

And, the elements in the off-diagonal boxes are the minimum mandatory actions that should be undertaken to work towards establishing earthquake safety in India.

Table 5: Inter-related elements in the five aspects of *Earthquake Disaster Rehabilitation*

Aspects	**Compensation**	**Temporary Shelters**	**Psycho-Social Trauma**	**Livelihood**	**Community**
Compensation	**Ex-Gratia**	Civil Supplies	Orphan Support	Minimum Wage	Donations
Temporary Shelters		**Health Standards**	Rehabilitation Centre	Aanganwadi Activities	Community Spaces
Psycho-Social Trauma			**Medical Support**	Unskilled workers	Privacy for Counselling
Livelihood				**Economic Activities**	Employment Guarantee
Community					**Social Activities**

3.5 Earthquake Disaster Reconstruction

Earthquake Disaster Reconstruction hinges on 5 aspects, namely *Technology*, *Money*, *People*, *Site* and *Safety*; these aspects are inter-related (**Table 6**). The elements on the diagonal boxes of the table are critical to Earthquake Disaster Reconstruction, namely:

(1) **Safe Type Designs**: Each region has certain types of houses built commonly. The unsafe typologies should be outlawed. These designs are likely to be more readily accepted during reconstruction. Hence, it is better to identify 2-3 type designs, especially for the *Low Income Group* category, and prepare earthquake resistant structural designs of these structures for

different soil conditions in the region. After an earthquake, these designs will be the starting points when discussing with the beneficiaries; the iterations will be reduced and time for finalization will be shortened;

(2) **Compensation**: When houses are damaged partially, compensation is paid to owners to restore them. The amount of compensation depends on the grade of damage. Categorizing buildings depending on the damage sustained by them is a formal structural engineering exercise. *Damage Assessment Teams (DATs)* need to be formed, which are trained formally on the nuances of the damages and their implications on life safety. Alongside the needed techno-financial and techno-legal systems should be put in place before the earthquake, to make damage assessment after the earthquake a legally protected technical exercise. Compensation should be paid only after a formal certification by the DATs. This damage assessment is not the Rapid Visual Survey that is understood commonly;

(3) **Owner or Contractor Driven Reconstruction**: Even if the type designs are acceptable to the community, social dynamics will determine the choice, whether post-earthquake reconstruction will be owner driven or contractor driven. Specially trained NGOs should mediate this decision making process and assist the government in speeding up the decision making and starting of the reconstruction;

(4) **In situ or New Sites**: Two thoughts may arise in communities after earthquakes where there is extensive collapse of houses – to build at the same site where the houses collapsed, or to go to a new site build afresh. If there is no special issue with the previous site (like permanent deformations of ground, liquefaction, fall of debris, and landslides), only then the in-situ option should be allowed. It may happen that only some would like to move to new site, while others may want in situ reconstruction. Again, a mediator NGO is necessary to help communities to take this decision; and

(5) **Permanent Shelter**: Even with the above four crucial contentious issues sorted out, the realization of the permanent

shelters should be a guided process. A construction management group is needed to keep track of the progress and complete the work on time.

And, the elements in the off-diagonal boxes are the minimum mandatory actions that should be undertaken to work towards establishing earthquake safety in India.

Table 6: Inter-related elements in the five aspects of *Earthquake Disaster Reconstruction*

Aspects	**Technology**	**Money**	**People**	**Site**	**Safety**
Technology	**Safe Type Designs**	Cost-Effective Design	Artisan/Owner Training	Local Materials	Testing
Money		**Compensation**	Compensation Policy	Land Title	Legalized Damage Assessment
People			**Owner or contractor driven**	Customization	Peer Review
Site				**Insitu or New Sites**	Land Use Planning
Safety					**Permanent Shelter**

4. PRIORITY INITIATIVES TOWARDS EARTHQUAKE RISK REDUCTION

Earthquake safety is a **technology problem**. Hence, technology upgrade across the nation at relevant levels can solve it. There are three urgent requirements to make earthquake disaster mitigation to get off the starting blocks and to reduce earthquake disaster risk, namely: (1) strong national will to address earthquake safety, (2) sustained national earthquake technology program to implement measures towards ensuring structural safety, and (3) national program for earthquake engineering education and research to prepare the hands that will implement structural safety. Details of some top priority initiatives are given hereunder. Only if **all** these are implemented, DM will switch to the **(bottom up)** *pull model*, much away from the current **(top down)** *push model*.

4.1 Long-Term Implementation

(a) Overhaul Technical Education and build Competent Technical Manpower

Unless the over 32 Crore existing constructions and all new constructions are made earthquake resistant, post-earthquake Response will not end. Leadership in the country (senior academics, bureaucrats and policy makers) needs to take bold steps to prepare large manpower over the next two decades, which is necessary to address earthquake safety of the country. Also, even it is an imperfect start with the available technical hands, Mitigation actions (*i.e.,* making safer constructions) need to be taken urgently, if India wishes to reduce the loss of life in upcoming earthquakes. Books on earthquake resistant design and constructions, focused development of teachers of civil engineering and architecture colleges in the domain of earthquake resistant design, mandatory architecture and engineering education curriculum, degree relevant programs, competent graduates, regulated practice and then earthquake resistant constructions – is the sequence of building an earthquake safe nation.

(b) Develop Capacity in Practicing Structural Engineers and Architects

With the ever changing landscape of technical education, technical component in the undergraduate education will continue diminish. Specialist knowledge can be imparted only at the levels of Masters and Doctoral degree program. This will be a threat to providing the needed precious **technical knowledge** to local and state governments towards implementing earthquake safety across the country, because most of them at the entry level will have only a bachelor's degree. A national program is needed on *earthquake engineering education*, with focus on enhancing competence of the practicing structural engineers and architects, to prepare at a faster pace the needed hands that can build earthquake safety in India. The program should emphasize specific competencies related to earthquake-resistant *design*, *construction* and *retrofitting*.

(c) Undertake Nationally Relevant Earthquake Research & Development

It is time for the nation to capitalize on the limited service-minded technical hands and establish a truly national center for R&D in earthquake safety. It should be charged with pointed terms of reference related to built environment of India – *earthquake hazard monitoring*, earthquake *hazard assessment*, earthquake *safety assessment* & earthquake *retrofitting technologies* for existing structures, and earthquake *resistant design technologies* for new structures.

(d) Develop Safety Standards at a Steady Pace

Even though the development of standards for earthquake resistant design and construction started in 1962, the progress in the last 58 years has been sluggish. Standards are available only for a limited set of structures, and that too only for earthquake hazard estimation and earthquake resistant design of buildings and a few other structures. Also, design of earthquake retrofit is missing for most structures. A formal and comprehensive plan should be rolled out for a steady development of earthquake standards, weeding out all deficient typologies and mandating on such structural typologies that are least likely to collapse during earthquakes.

4.2 Short-Term Implementation

(a) Need Bold Leadership

This is required to catapult out of the current quagmire of low motivation and limited resources gazing a high risk situation of earthquake safety of India. Leadership should:

(i) Embark on modest starts, how much ever imperfect they are, along different verticals discussed in the paper.

(ii) Shed generic Disaster Management solutions, which are drawn up at the center for all states, districts and towns, towards making India safer from future earthquakes, decentralize Earthquake Disaster Management to DDMAs, strengthen **Local Governance**, and provide *technical support* from NDMA and *financial support* (for the government-owned structures) from SDMA.

(b) Establish Strong Regulatory System

Four primary legal tools are required to ensure earthquake resistance in the built environment of the country, namely:

(1) Establishing the system of Licensing of Engineers,

(2) Mandatory requirement to verify structural safety before starting construction of any structure,

(3) Dropping the mandatory requirement in all government projects, which is imposed through orders by Government Departments and Ministries of Central and State Governments and UT Administrations across the nation, of seeking approval of structural safety from Faculty Members of IITs and NITs (This will help teachers do teaching and research, their primary tasks!), and

(4) Make compliance of all Indian Standards mandatory in all projects across the country, instead of their current recommendatory status.

(c) Undertake Selective Earthquake Retrofit

Undertake Retrofitting of select structures – say, all government-owned *schools* and *hospitals*. Also prepare a comprehensive plan for promoting systematic, formal and technically sound retrofitting of *houses* of all typologies, as it not only involves technology issues but also social issues.

(d) Launch Model District Program

Do it differently!! Begin in 1 of the 720 districts the work of Earthquake Disaster *Mitigation* based on understanding of best practices in India and worldwide. Then, improve the systems and processes and adapt/adopt the best practices in the remaining 719 districts of the country. Implement this blitzkrieg *Earthquake Resistant Model District Program (ERMDP)*, in a crisp 1 Year and share the success with the rest of the country. The goal of ERMDP should be to ensure that all new structures are earthquake resistant. And, the focused agenda items of the ERMDP should be Items 4.2(a), (b) and (c) described above.

(e) Document Lessons from Earthquakes

Post-earthquake Reconnaissance Surveys by experienced multi-disciplinary teams are valuable to capture perishable lessons that earthquakes leave behind for us to learn from. Such teams should be dispatched at the earliest, with a mandate not to disturb the emergency Response work. Also, after the emergency is over, younger competent Damage Assessment Teams should be sent to the affected area to gather more details on the certain items that were identified in the Post-earthquake Reconnaissance Surveys.

5. THE WAY FORWARD…

The environment is appropriate to launch in national interest a national program on earthquake safety. As part of this, the three primary stakeholders should rise to the occasion – Academia, Government and Industry. They need to affect the needed change by their dedicated, committed and focused roles in their respective domains of work. Change is inevitable...!! But, it will be sustainable only if all efforts from today are pegged on one basic premise – *Life of each Indian is precious*.

References

1. BMTPC, (2017), *Vulnerability Atlas of India*, Building Materials and Technology Promotion Council, New Delhi
2. DMA, (2005), *Disaster Management Act, 2005*, Government of India
3. DMP, (2009), *National Policy on Disaster Management*, National Disaster Management Authority, Government of India
4. DMP, (2019), *National Disaster Management Plan*, National Disaster Management Authority, Government of India
5. Jain,S.K., Murty,C.V.R., Chandak,N.N., Seeber,L., and Jain,N.K, (1994), "The September 29, 1993, M6.4 Killari, Maharashtra, Earthquake in Central India," EERI Special Earthquake Report, *EERI Newsletter*, Vol.28, No.1, January 1994, 8 pages
6. Jain,S.K., Murty,C.V.R., Arlekar,J.N., Sinha,R., Goyal,A., and Jain,C.K, (1997), "Some Observations on Engineering Aspects of the Jabalpur Earthquake of 22 May 1997," EERI Special Earthquake Report, *EERI Newsletter*, Vol.32, No.2, August 1997, pp 1-8

7. Jain,S.K., Murty,C.V.R., Arlekar,J.N., Rajendran,C.P., Rajendran,K., and Sinha,R., (1999), "The Chamoli, India, Earthquake of March 29, 1999," EERI Special Earthquake Report, *EERI Newsletter*, Vol.33, No.7, July 1999, pp 1-8

8. Jain,S.K., Lettis,W.R., Arlekar,J.N., Ballantyne,D., Chaubey,S.K., Dayal,U., Goel,R., Goyal,A., Hengesh,J., Malhotra,P., Murty,C.V.R., Narula,P.L., Saikia,C.K., Singh,M.P., and Vatsa,K., (2001), "Preliminary Observations on the Origin and Effects of the January 26, 2001 Bhuj (Gujarat, India) Earthquake," EERI Special Earthquake Report, *EERI Newsletter*, April 2001, pp 1-16

9. Jain,S.K., Murty,C.V.R., Rai,D.C., Malik,J.N., Sheth,A.R., Jaiswal,A., Sanyal,S.A., Kaushik,H.B., Gandhi,P., Mondal,G., Dash,S.R., Sodhi,J. S., Santhosh,G., (2005), "The Great Sumatra Earthquake and Indian Ocean Tsunami of December 26, 2004," EERI Special Earthquake Report #3, *EERI Newsletter*, April 2005, pp 1-12

10. Murty,C.V.R., (2007), *IITK-BMTPC Earthquake Tips*, National Information Centre of Earthquake Engineering, IIT Kanpur

11. Murty,C.V.R., Sheth,A.R., and Rai,D.C., (2011), "M6.9 Sikkim Earthquake of September 19, 2011," EERI Learning from Earthquakes, *EERI Newsletter*, Vol.45, No.11, November 2011 pp 6-7

12. Murty,C.V.R., Raghukanth, S.T.G., Menon,A., Goswami,R., Vijayanarayanan,A.R., Gandhi,S.R., and Satyanarayana,K.N., Sheth,A.R., Rai,D.C., Mondal,G., Singhal,V., Parool,N., and Pradhan,T., Jaiswal,A., Kaushik,H.B., Dasgupta,K., Chaurasia,A., Bhushan,S., Roy,D., and Pradeep Kumar,R., (2012), "The Mw 6.9 Sikkim-Nepal Border Earthquake of September 18, 2011," EERI Special Earthquake Report, *EERI Newsletter*, February 2012, pp 1-14

13. Murty,C.V.R., Chourasia,A., Kumar,H., Karanth,A., and Kumar,R.P., (2013), "Lessons from 1st May 2013 Doda (India) Earthquake Reiterate Urgent Need to Mitigate Seismic Risk," *Disasters and Development*, Vol.7, No.1-2, pp 114-130, NIDM, New Delhi

14. NDMG-BLI, (2010), *National Disaster Management Guidelines - On Ensuring Disaster Resilient Construction of Buildings and Infrastructure financed through Banks and Other Lending Institutions*, National Disaster Management Authority, Government of India

15. NDMG-SR, (2014), *National Disaster Management Guidelines – Seismic Retrofitting of Deficient Buildings and Structures*, National Disaster Management Authority, Government of India

16. NDMG-HS, (2016), *National Disaster Management Guidelines – Hospital Safety*, National Disaster Management Authority, Government of India

17. NDMA, (2019a), *Home Owner's Guide for Earthquake and Cyclone Safety*, National Disaster Management Authority, Government of India

18. NDMA, (2019b), *Earthquake Disaster Risk Index Report*, National Disaster Management Authority, Government of India

19. NDMA, (2020), *A Primer on Rapid Visual Screening (RVS): Consolidating Earthquake Safety Assessment Efforts in India*, National Disaster Management Authority, Government of India

20. Rai,D.C., and Murty,C.V.R., (2005), "The Kashmir Earthquake of October 8, 2005," EERI Special Earthquake Report, EERI Newsletter, December 2005, pp 5-8.

21. Seeber,L., and Jain,S.K., Murty,C.V.R., and Chandak,N.N., (1993), "Surface Rupture and Damage Patterns in the Ms=6.4, September 29, 1993, Killari (Latur) Earthquake in Central India," *NCEER Bulletin*, Vol.7, No.4, October 1993, page 12

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Cyclones and Disaster Management

Abstract: North Indian Ocean (NIO) is a breeding ground for the disastrous Tropical Cyclones (TCs). Thus, monitoring and prediction of TCs accurately is very crucial for building a disaster resilient society. IMD maintains a round the clock watch over the NIO to monitor any development of cyclonic disturbance, it's intensification, movement and impact. In this study a review of the countdown procedure for management of TCs is carried out with case of Super Cyclonic Storm "Amphan" as an illustrative example. It will help disaster managers, media and general public to understand the entire process of monitoring and predicting TCs.

Key words: Tropical cyclones, countdown, extended range, medium range, short range, forecast, warning and disaster management

1. INTRODUCTION

As per the World Meteorological Organisation (WMO), based on the observations during 1970-2019, 33% of the hydro meteorological disasters are caused by tropical cyclones (TCs). In addition, TCs also rank one out of three events that killed most people globally and seven out of ten disasters that caused the biggest economic losses in the world during the same period. The tropical warm north Indian Ocean (NIO), like the tropical North Atlantic, the South Pacific and the northwest Pacific, is a breeding ground for the disastrous TCs. Almost all coastal districts of India are prone to disasters associated with TC, though the degree of proneness varies from district to district [Mohapatra *et al*, 2012; Mohapatra, 2015a].

There are 13 coastal states/UTs encompassing 84 coastal districts which are affected by cyclones. Four states (Andhra Pradesh, Odisha, Tamil Nadu and West Bengal) and one UT (Puducherry) on the East Coast and one state (Gujarat) on the West Coast are more vulnerable to TCs and associated storm surge (Mohapatra, 2015). Though NIO accounts for only 7% of global cyclones, in terms of loss to human life, the Bay of Bengal (BoB) has experienced more than 75% of the total world-wide TCs causing human death of 5,000 or more in last 300 years [Dube *et al*, 2013].

Considering the disastrous impact of TCs on life and property, it is highly pertinent to improve TC forecasting abilities thereby reducing death and damage. The reduction of cyclone disasters depends on several factors including hazard analysis, vulnerability analysis, preparedness & planning, early warning, prevention and mitigation. Early warning system is a major component of disaster management in the event of TCs. Increase in lead period along with increase in accuracy of the forecast of genesis, track, intensity and adverse weather help in better management of disaster due to tropical cyclones. It is thus important to continuously upgrade all the components of early warning based on latest technology for effective management of TCs. Major components of early warning primarily include policy & planning, vision & strategy, observations, skills in monitoring and predicting TCs, modeling, forecasting, effective warning products generation & dissemination, coordination with emergency response units, capacity building, outreach and public perception about the credibility of the official predictions. IMD thus continuously upgrades and improves its observational network, modeling & technological capabilities, networking with other scientific agencies & disaster managers, warning dissemination mechanism and outreach.

IMD maintains a round the clock watch over the region, follows a well defined standard operation procedure (SOP), utilizes an array of global & regional models both deterministic and probabilistic, a highly developed decision support system (DSS) for monitoring & predicting TCs and all conventional & modern means of communication for disseminating cyclone warnings. At present IMD is receiving and processing meteorological data from two Indian geostationary satellites namely INSAT-3D and INSAT-3DR, one polar orbiting satellite SCAT-SAT and other international satellites when the TCs are over sea. Over the land, IMD has a dense network of 711 automated weather stations, 1350 automated rain gauges, 27 radars, 20 high wind speed recorders along the coast, 62 pilot balloon observatories and 43 radio sonde/radio wind stations country wide for facilitating meteorological observations for monitoring and predicting TCs.

As a result, there has been significant improvement in TC forecast accuracy including track, landfall, intensity and adverse weather like gale wind, heavy rain & storm surge [Mohapatra *et al*, 2013a, 2013b and 2013c, 2015; Mohapatra, 2015b; and Mohapatra and Sharma, 2019]. There has been reduction in track forecast error from 181, 420 and 483 km in 2009 to 69, 104 and 149 km in 2019 for 24, 48 and 72 hrs lead period and landfall forecast errors to less than 40 km upto 72 hrs in 2019 (RSMC New Delhi, 2010 & 2020).

In this study, an analysis of the various steps, taken by IMD as a countdown measure with DM agencies for effective management of TCs has been carried out. The brief climatology of TCs over the NIO, data & products used for TC monitoring and prediction, standard operating procedure (SOP) for monitoring, forecasting and warning, liaison mechanism with disaster managers, warning dissemination techniques and the countdown to the arrival of TC with super cyclone "Amphan" during 2020 as an illustrative example have been presented and discussed.

1.1 Climatology of TCs over the NIO

Generally, under favourable environmental conditions, a cyclonic circulation develops into a low pressure area (LPA) characterized by associated anticlockwise rotating winds with maximum sustained wind speed (MSW) less than 17 knots. Under favorable environmental conditions, it intensifies into a depression (D), deep depression (DD), cyclonic storm (CS), severe cyclonic storm (SCS), very severe cyclonic storm (VSCS), extremely severe cyclonic storm (ESCS) and super cyclonic storm (SuCS) [WMO, 2016]. The depression and cyclones together are known as cyclonic disturbances (CDs). The detailed classification of CDs is presented in **Table 1**.

On an average, about 11 CDs develop over the NIO during a year including 9 over the Bay of Bengal (BOB) and 2 over the Arabian Sea (AS) [Mohapatra *et al*, 2014b]. Out of these, about five intensify into CS (4 over BOB and 1 over the AS), 3 into SCS (2 over BOB and 1 over the AS) and 1-2 into VSCS. The annual average frequency of formation of TCs accounts for about 7% of the global TCs. There are primarily two major cyclone seasons in India, namely the pre monsoon (April-June) and post monsoon season (October-December). Thus, the frequency of TCs shows bimodal behavior with primary peak in November and secondary peak in May (IMD, 2008). Similar is the case with severe TCs. However, the frequency of CDs (depressions and TCs) does not show such behavior as maximum number of depressions form during monsoon season. The frequency of CDs shows maxima in October followed by November. On an average, it takes about 2 to 3 days for the development of a low pressure area into a D/DD. The intensification from a D/DD to SCS/VSCS can occur in 1 to 2 days (IMD, 2003).

Table 1: Classification of cyclonic disturbances over the NIO (since 2015)

Category of Low Pressure System	**Maximum Sustained Surface Winds (knots)**
Low pressure area (LPA)	< 17
Depression (D)	17 - 27
Deep Depression (DD)	28 - 33
Cyclonic Storm (CS)	34 - 47
Severe Cyclonic Storm (SCS)	48 - 63
Very Severe Cyclonic Storm (VSCS)	64 - 89
Extremely Severe Cyclonic Storm (ESCS)	90 - 119
Super Cyclonic storm (SuCS)	> 120

2. DATA AND METHODOLOGY FOR MONITORING & FORECASTING OF TCs

The analysis and prediction of tropical cyclones (TCs) involves blending of conceptual, dynamic and statistical models, meteorological observations, technology and forecaster's expertise. For analysing current location, intensity and structure of a TC, data is collected from following available sources:

(1) Surface observations from coastal observatories, island stations, ships, buoys and coastal observations from World Meteorological Organisation/ Economic and Social Commission for Asia & Pacific (WMO/ESCAP) Panel member countries available through global telecommunication system (GTS) [IMD, 2013];

(2) Satellite observations including various geostationary and polar orbiting satellites in visible, infra-red and microwave bands. The satellites include INSAT-3D, INSAT 3D (R), SCAT SAT, ASCAT (*https://manati.star.nesdis.noaa.gov/products.php*) and the products available from US Navy National Research Laboratory (NRL) (*https://www.nrlmry.navy.mil/tc_pages/tc_home.html*), Co-operative Institute for Meteorological Satellite Studies (*http://tropic.ssec.wisc.edu/*), WMO's Tropical Cyclones Forecaster website (*https://severeweather.wmo.int/TCFW/*);

(3) Dvorak T.No. estimates available from INSAT 3D/3DR and other international satellites [Dvorak, 1984];

(4) Radar imageries and products from IMD [Raghavan, 2013] and neighbouring countries;

(5) Climatology of tracks of TCs over NIO [IMD, 2008]; and

(6) Climatology of structure of TCs over NIO [Mohapatra and Sharma, 2015].

For predicting cyclogenesis (development of depression), guidance from an array of models including IMD's Genesis Potential Parameter Index, Multi Model Ensemble Coupled Forecast System Version 2 (MME CFSv2), Global Forecast System (GFS),Weather Research & Forecast (WRF) & Global Ensemble Forecast System (GEFS) adapted and customised by Indian Institute of Tropical Meteorology (IITM), Pune; National Centre for Medium range Weather Forecasting (NCMRWF) Unified Model (NCUM) & Ensemble Prediction System (NEPS), National Centre for Environment Prediction (NCEP)-GFS, European Centre for Medium Range Weather Forecasting (ECMWF), Japan Meteorological Agency (JMA) and Meteo France model is utilized following the criteria for genesis (IMD, 2013). In addition, broad scale features like Madden Julian Oscillation Index, La-Nina, Indian Ocean Dipole conditions which influence TC genesis, intensification and movement are also monitored [Mohapatra and Sharma, 2019].

For predicting the track, landfall, intensity and adverse weather, in addition to models discussed in previous paragraph, IMD also utilizes guidance from IMD's Multi Model Ensemble (MME) system, cyclone specific hybrid ocean coupled Hurricane Weather Research & Forecast (Hy-Com HWRF) model, Statistical Cyclone Intensity Prediction (SCIP) model and Rapid intensification/weakening model.

3. STANDARD OPERATION PROCEDURE FOR MONITORING OF TCs

IMD has a standard operation procedure (SOP) for effective management of cyclone warning activity over the NIO [IMD, 2013; Sharma and Mohapatra, 2017]. Various kinds of analytical procedures are described in the SOP Manual [IMD, 2003, 2013]. A systematic check list is prepared for identification and prediction of location, intensity, landfall and adverse weather associated with a TC [Sharma and Mohapatra, 2017]. In addition to all the observations and model guidance, IMD utilizes a digitized forecasting platform to compare, comprehend and analyse guidance from various sources for making final decision and generating user friendly warning products. The DSS has the facility to plot and analyse different weather parameters, satellite, radar and NWP model products in GIS platform at one system with a facility to generate warning graphics. The analysis and prediction of a TC involves blending guidance from dynamic and statistical models, meteorological observations & technology with knowledge, experience & expertise of forecaster. An objective consensus is developed from the analysis of meteorological observations and forecast from an array of numerical weather prediction models utilizing a decision support system. It is modulated by a subjective consensus drawn from the exchange of knowledge, experience and expertise of cyclone forecasters of IMD through video conferencing system.

4. LIAISON WITH DISASTER MANAGERS

IMD has a three tier organizational structure for cyclone warnings with Cyclone Warning Division (CWD) at IMD headquarters, 3 Area Cyclone Warning Centres (ACWCs) at Chennai, Mumbai & Kolkata and 4 Cyclone Warning Centres (CWCs) at Bhubaneswar, Visakhapatnam, Thiruvananthapuram and Ahmedabad to cater to the country's requirements. Also, the CWD is co-located with Regional Specialised Meteorological Centre for Tropical Cyclones and Tropical Cyclone Advisory Centre for civil aviation. At regional level, the Director General of Meteorology leads all discussions with WMO and Permanent Representatives of all 13 WMO/ ESCAP Panel member countries. At national level, the management of cyclone is considered at highest level. Once the warning is issued by IMD for any cyclone threatening the coast, the National Crisis Management Committee (NCMC) headed by Cabinet Secretary, Government of India meets regularly for preparedness and necessary actions. All concerned stakeholders including DG, IMD participate in this meeting. The Director General of Meteorology (DGM) is responsible for briefing the Prime Minister Office, NCMC, Cabinet & Home Secretary and Chief Secretaries of affected states. At national level, liaisons are also made with central level disaster managers including the National Emergency Response Centre (NERC), MHA, National Disaster Management Authority (NDMA), National Disaster Response Force (NDRF). State Chief Secretaries and other stakeholders, like Railways, Roadways, air transport, shipping, defence, coast guards, ports, fisheries, agriculture, drinking water and sanitation, health, power, telecommunication authorities, and press & electronic media (especially Doordarshan, and India Radio, FM and community radios). The ACWCs and CWCs are responsible for liaison with similar authorities at state and district level.

5. WARNING DISSEMINATION MECHANISM

Cyclone warnings are disseminated to users through all possible means including telephone, fax, email, SMS, Global Telecom System (GTS), WMO Information System (WIS), All India Radio, FM & community radio, Television and other print & electronic media, press conference, press briefings & press release. These warnings/advisories are put on the websites (*www.rsmcnewdelhi.imd.gov.in*, *www.mausam.imd.gov.in*) of IMD. IMD in collaboration with Ministry of Agriculture and INCOIS sends cyclone alerts through SMS to disaster managers, media, general public, fishermen and farmers. IMD acts as a Global Maritime Distress and Safety System (GMDSS) Centre for the BoB and AS region and hence provides three hourly cyclone forecast message to shipping communities through international telecommunication channels. This message is also put in RSMC, New Delhi website (*www.rsmcnewdelhi.imd.gov.in*). The WMO Information System (WIS) Portal is utilized for cyclone warnings dissemination (*http://www.wis.imd.gov.in*) to international users and stakeholders. IMD also issues forecast bulletins to shipping communities in the BoB and AS upto about 450 km from the coast through NAVTEX established by Department of Light House and Light Ships, Ministry of Ports and Shipping. IMD is also working in collaboration with ISRO for disseminating the SMS to fishermen in deep seas through GAMES and NAVIC systems. IMD also notifies cyclone warnings on various mobile apps like Mausam, Umang and Meghdoot. IMD has also started the dissemination of weather information through common alerting protocol. IMD posts all updated information on social networking sites including Facebook, Twitter and whatsapp groups. During cyclone time all possible means of communication are utilized to reach last mile by IMD offices and various disaster management agencies individually and collectively in the country.

6. COUNTDOWN TO THE ARRIVAL OF TC WITH DISASTER MANAGEMENT

Monitoring of TCs is a systematic process. The TCs are monitored in various temporal scales. The **first step of** countdown to the arrival of TC commences with the organization of pre-cyclone exercise in the beginning of a cyclone season, namely, in the beginning of April and October. IMD head quarter and various sub-offices involved in TC monitoring take stock of their preparedness for ensuing cyclone season with respect to inventories, instruments, computers, radars and update contact details. As a part of pre cyclone exercise, the meeting is organised to develop direct interaction with the disaster managers and to create awareness about lessons learnt & initiatives during the ongoing season for management of cyclone. Letters are issued by IMD to all stakeholders, like All India Radio, TV, Ports, Fisheries, Department of Telecommunication, NDRF, and to disaster managers at national, state and district level to organize pre-cyclone exercises and actions for the season. In some states, the mock cyclone exercise is also conducted with participation of IMD. In the coastal states as a part of pre cyclone exercise, the meeting is arranged under the chairmanship of Chief Secretary with all state level stakeholders and IMD.

The tropical cyclone monitoring is carried out by IMD with round the clock watch. The **second step** of countdown with disaster managers starts with issue of extended range forecast (15 days forecast) for possible cyclogenesis. An extended range outlook is issued every Thursday giving probability of cyclogenesis (formation of depression) as low (1-33%), moderate (34-67%) and high (68-100%) for next 2 weeks. This bulletin is uploaded in IMD website and also communicated to all concerned.

As a **third step** of countdown, the daily watch is maintained over the NIO and a detailed bulletin discussing the model guidance, prognostic & diagnostic features and probability of cyclogenesis during next 7 days is prepared. A bulletin "Tropical Weather Outlook" is issued everyday throughout the year discussing the convective cloud features over the Indian seas and probability of cyclogenesis during next 5 days as nil (0%), low (1-25%), fair (26-50%), moderate (51-75%) and high (76-100%).

As a **fourth step**, when a low pressure area develops over the region, six hourly bulletins commence from National Weather Forecasting Centre of IMD indicating possible intensification and cyclogenesis. A special message is issued to disaster managers and also a press release indicating the possible intensification and expected adverse weather along the coast.

As a **fifth step**, as soon as the low pressure area intensifies into a depression, the "Special numbered bulletins" are issued 5 times a day for international/national users giving description of current & forecast location, intensity, movement upto 72 hrs alongwith associated adverse weather, damage expected and action suggested.

As a **sixth step**, when the depression intensifies into a cyclonic storm, three hourly bulletin "Tropical Cyclone warning and Advisory" commences giving all the details as mentioned above with the forecast up to next five days. In India four stage warning system is used. Pre Cyclone Watch is issued at least 72 hours prior to commencement of adverse weather along a coast. Cyclone Alert is issued at least 48 hours and Cyclone Warning at least 24 hours prior to commencement of adverse weather along a coast. Post landfall outlook is issued at least 12 hours prior to landfall giving description about the intensity, movement and adverse weather associated with the system after landfall till the system maintains the intensity of cyclonic storm.

As a **seventh step**, the hourly bulletins commence at least 12 hours prior to landfall giving description about the cyclone on hourly basis about its current status and forecast, landfall process, ongoing and expected adverse weather like heavy rain, wind and storm surge.

As **an eighth step**, after landfall, regular three hourly bulletins continue till the system maintains cyclone intensity. It is followed by six hourly bulletins when it weakens into a deep depression stage and till it becomes insignificant. The de-warning for a coast is also issued, in case the cyclone weakens over sea under adverse environmental conditions or the coast becomes free from cyclone impact.

As a **ninth step**, after dissipation of the cyclone, within seven days, a preliminary report is prepared including brief life history, performance of forecast and warning services, challenges and lessons learnt in association with a system and the same is communicated to disaster managers and press and electronic media. This is also uploaded in IMD website and vital parameters of the cyclone are archived in digital form in the archive page of website for future reference as well as research and development.

7. COUNTDOWN FOR SUPER CYCLONIC STORM "AMPHAN" WITH DISASTER MANAGEMENT

For monitoring of cyclone Amphan, the preparation commenced in the beginning of April. At the onset of cyclone season (April-June), pre-cyclone exercise was held during 1st week of April at IMD headquarters and various sub-offices of IMD to take stock of the preparedness for the ensuing cyclone season. Daily diagnosis and prognosis commenced from 25 April as per SOP. The first alert about possible development of cyclone was sounded on 7 May. The entire countdown process involved in monitoring the approaching super cyclone Amphan is described below:

(1) Countdown stage 8 (6th May 2020, 1330 hrs IST)

The countdown process started on 6th May, 2020 when IMD got first signal about the possible cyclogenesis over the BoB with the formation of upper air cyclonic circulation over south Andaman Sea which had the potential for intensification. Since then continuous monitoring started with issue of 4 bulletins per day by National Weather Forecasting Centre of IMD in association with the cyclonic circulation meandering over south Andaman Sea

(2) Countdown stage 7 (7th May 2020, 1330 hrs IST)

The extended range outlook issued on 7th May (about 6 days prior to formation of Low pressure area on 13th May, 9 days prior to formation of depression and 13 days prior to landfall on 20th May) indicated cyclogenesis over south BoB with movement towards north BoB. The IMD continued to monitor and issue four bulletins per day during 7th-12th May in association with the cyclonic circulation

(3) Countdown stage 6 (13th May 2020, 1330 hrs IST)

It began on 13th May, the day of formation of LPA over south Andaman Sea (3 days prior to formation of depression on 16th and 7 days prior to landfall). A Special Informatory Message was sent to the concerned central and state level disaster managers of east coast states and Andaman Nicobar Islands at 1330 hrs IST indicating the likely development of a cyclonic storm over BoB. Press Release was also issued for media & general public in this regard. IMD issued a press release and a special bulletin indicating the formation of low pressure area and its possible intensification into a cyclone. It further advised the fishermen not to venture into identified sea region which was expected to experience adverse weather. IMD continued its monitoring prediction in connection with this low through its daily four bulletins till 16th May.

(4) Countdown stage 5 (16th May 2020, 0845 hrs IST) – Pre-Cyclone Watch

It commenced with the intensification of low pressure area into a depression over southeast BoB on 16th May morning. IMD started issuing numbered and structured quantitative track and intensity forecast as well as adverse weather warning. In the first bulletin in this series released at 0845 hrs IST of 16th May (104 hrs prior to landfall), Pre-cyclone Watch for West Bengal-north Odisha coasts was issued. In the bulletin, it was indicated that the system would intensify into a cyclonic storm and cross the West Bengal coast with maximum sustained wind speed of 155-165 kmph gusting to 180 kmph. It was also indicated that the system would cause heavy to very heavy falls at a few places with extremely heavy falls at isolated places over Gangetic West Bengal (GWB) on 20th May. For coastal Odisha, heavy rainfall at isolated places from 18th May evening, heavy to very heavy falls at a few places on 19th May and isolated heavy rainfall over northeast Odisha on 20th May 2020 was predicted.

The first NCMC meeting was conducted under the chairmanship of the Cabinet secretary on 16th May forenoon for the preparedness measures and similar meetings were conducted at state level in Odisha and West Bengal. All the stakeholders and disaster management agencies at national level and Chief Secretaries of Odisha and West Bengal participated in this meeting. DGM, IMD made a presentation on current status and forecast about cyclone, expected adverse weather, area to be affected, damage expected and the suggested actions. Accordingly the actions were planned as per the instruction of NCMC.

(5) Countdown stage 4 (16th May 2020, 2030 hrs IST) – Cyclone Alert

It began with the intensification of depression into CS Amphan in the evening of 16th May. The warnings were further upgraded and Cyclone Watch for West Bengal and north Odisha coasts was issued at 2030 hrs IST of 16th May (92 hrs prior to landfall). Structured 3 hourly bulletins commenced from 16th evening onwards with regular updates on all sites and social platforms. Cyclone watch was upgraded to Cyclone Alert (Yellow Message) for West Bengal and north Odisha coasts and was issued at 0840 hrs IST of 17th May (80 hrs prior to landfall). It was indicated that the squally wind speed of 40 to 50 kmph would commence along and off Odisha coast from 19th May morning and along & off West Bengal coast from 19th May evening. It was predicted to gradually increase becoming maximum wind of 100-110 kmph gusting to 120 kmph along and off coastal districts of north Odisha during 20th May early morning to afternoon and 155-165 gusting to 185 kmph along and off West Bengal coast during 20th afternoon to night (during the time of landfall). In the bulletin issued at 2030 hrs IST of 17th when the system lay as VSCS over south BoB, extensive damage expected and action suggested corresponding to the stage of ESCS was predicted for north Odisha and West Bengal coastal districts. It was precisely indicated that the system would cause extensive damage to all types of kutcha houses and some damage to old badly managed concrete structures. The flying objects were potential threats. Extensive uprooting of communication and power poles was expected. The system was expected to cause disruption of rail/road link at several places, extensive damage to standing crops, plantations & orchards, blowing down of palm and coconut trees and uprooting of large bushy trees. Large boats and ships were expected to get torn from their moorings. At this stage, total suspension of fishing operations during 18th to 20th May 2020 and diversion or suspension of rail & road traffic was suggested. People in affected areas were advised to remain indoors. The disaster management authorities were advised to mobilise evacuation from low lying areas. People were advised to avoid movement in motor boats and small ships.

(6) Count down stage 3 (18th May 2020, 0845 hrs IST) – Cyclone Warning

The cyclone alert was upgraded to cyclone warning. It started with the intensification of Amphan into an ESCS on 18th early morning. Cyclone Warning (Orange Message) for West Bengal and north Odisha coasts was issued at 0845 hrs IST of 18th May (56 hrs prior to landfall). In this bulletin, it was also indicated that storm surge of about 4-5 m above astronomical tide would inundate low lying areas of south & north 24 Parganas and about 3-4 meters over east Medinipur dstricts of West Bengal around the time of landfall. Subsequently, it intensified into an SuCS around noon of 18th. Continuous monitoring and prediction of it's location, track intensity and associated adverse weather continued. Regular 3 hrly bulletins along with organization of joint press conferences by IMD and NDRF commenced for creating awareness among the masses about the impending disaster.

The second NCMC meeting was conducted under the chairmanship of Cabinet secretary on 18th May forenoon for reviewing the preparedness measures and similar meetings were conducted at state level in Odisha and West Bengal. The review meeting was also conducted under the chairmanship of Hon'ble Home Minister on 18th May noon. Another review meeting was also conducted under the chairmanship of Hon'ble Prime Minister on 18th May afternoon with participation of concerned high level disaster management authorities and DGM, IMD presented the current status and forecast of super cyclone Amphan, area districts to be affected, expected damages and suggested actions in these review meetings. Accordingly the follow-up actions on the ongoing preparedness and mitigation measures were sharpened for necessary action. The Joint Press Conferences organized by the Press Information Bureau (PIB) were addressed by DGM IMD and DG NDRF on 18^{th}, 19^{th}, 20^{th} and 21^{st} May for briefing media and general public about the impact of SuCS Amphan. DGM IMD also appeared live on Facebook on 18^{th} May and facilitated frequent briefings to media persons from IMD HQ and CWC, Bhubaneswar and Kolkata to create awareness among masses about the expected adverse weather and damages in association with Amphan and actions to be taken by disaster managers and general public.

(7) Count down stage 2 (19^{th} May, 2330 hrs IST) – Post-Landfall Outlook

It commenced in the midnight of 19^{th} May (17 hrs prior to landfall) with the release of post landfall outlook (Red Message) for interior districts of Gangetic West Bengal, Assam and Meghalaya after landfall in addition to continued cyclone warning for coastal districts of north Odisha and West Bengal. The third NCMC meeting was conducted under the chairmanship of Cabinet secretary on 19^{th} May forenoon

(8) Countdown stage 1 (20^{th} May 2020, 0630 hrs IST) – Hourly Updates

It commenced from 0630 hrs IST of 20th May when the system lay about 155 km south of Paradip and 280 km south-southwest of Digha. IMD started issuing hourly updates on current location, intensity, closest distance from different coastal cities/towns of Odisha, West Bengal and Bangladesh, current observation w.r.t. rainfall and wind and forecast track, intensity, wind, rainfall and storm surge. This continued till the system crossed and thereafter maintained the intensity of cyclone. A total of 20 special hourly updates were issued in this regard.

(9) Count down stage zero (20th May 2020, 1430 hrs IST) – Commencement of landfall process)

It started with the commencement of **the** landfall process at 1430 hrs IST of 20th May, continued for 2-3 hours and the system crossed West Bengal coast between Digha (West Bengal) and Hatiya Islands (Bangladesh) over Sundarbans between 1530 and 1730 hrs IST of 20th May with wind speed of 155-165 gusting to 185 kmph and maximum storm surge of 4.6 meter above the astronomical tide as per prediction. Also the extremely heavy rainfall occurred over north coastal Odisha districts and coastal districts of West Bengal including Kolkata as per prediction.

(10) Count up stage 1 (20th May 2020, 1830 hrs IST) – Post landfall follow up

Thereafter, hourly bulletins continued till the system maintained the CS intensity over Indian Region i.e. till 0230 hrs IST of 21st May. It passed over Kolkata around 2100 hrs IST of 20th May as a VSCS with wind speed of 120-130 kmph gusting to 145 kmph as per the prediction 3 days earlier. Regular 3 hourly bulletins continued till the system maintained the CS intensity (morning of 21st May). Six hourly structured bulletins in the weakening phase continued for various users till midnight of 21st May by IMD. Thereafter, IMD maintained watch over the system till it became insignificant and issued regular six hourly bulletins.

(11) Count up stage 2 (21st May 2020, 1330 hrs IST) – Preparation of Preliminary Report

The preliminary report on the system was prepared and released in the form of a press release on 21 May 2020. Detailed report on cyclone Amphan was issued on 13 June 2020. The fourth NCMC meeting was conducted under the chairmanship of Cabinet secretary on 21st May forenoon for post landfall follow-up actions

IMD issued a total of 3 informatory messages prior to genesis, 45 national bulletins for national disaster managers, 45 bulletins for WMO/ESCAP members including Bangladesh & Myanmar, 11

Press Release and 19 hourly bulletins apart from other user specific bulletins in association with SuCS Amphan. All these bulletins and messages were sent by email & FAX to central and state level disaster managers and through Global Telecommunication System (GTS) to WMO/ESCAP member countries. The messages were also flashed on all social networking sites including various websites of IMD (*www.mausam.imd.gov.in*, *www.rsmcnewdelhi.imd.gov.in*, *www.internal.imd.gov.in*), Facebook, Twitter, mobile apps, Common Alerting Protocol (CAP), SMS, whatsapp, *etc*. The Joint Press Conferences organized by Press Information Bureau (PIB) were addressed by DGM IMD and DG NDRF on 18th, 19th, 20th and 21st May for briefing media and general public about the impact of SuCS Amphan. DGM IMD also appeared live on Facebook on 18th May and facilitated frequent briefings to media persons from IMD HQ and CWC, Bhubaneswar and Kolkata to create awareness among masses about the expected adverse weather and damages in association with Amphan and actions to be taken by disaster managers and general public.

8. DECISION MAKING DURING COUNTDOWN WITH DM

TC forecasting is very tricky and challenging considering the dynamic nature of its track and intensification/weakening and associated adverse weather and impact [Mohapatra & Sharma, 2017; Heming *et al*, 2018]. During real time, disaster managers demand accurate prediction with sufficient lead time. On the other hand, the forecaster face challenges with respect to timely availability of data, availability of model guidance and effective communication facilities. Thus, decision making requires great skills with respect to analysis of observations and generation of end forecast in a time bound manner.

It can be better understood considering a live example of TC Amphan. The forecasters faced multiple challenges with respect to the prediction of the genesis, landfall point, landfall time and intensification. Even predicting genesis (formation of depression) was a challenge. Amphan originated from the remnant of a low pressure area (LPA) which persisted over south Andaman Sea during 1st – 6th May. This remnant cyclonic circulation meandered over southeast BoB for a long time up to 12th May. It again organised as an LPA on 13th May over southeast BoB that in due course intensified into SuCS Amphan. Considering the model guidance about genesis, there was false alarm from 25th April onwards about the genesis of the cyclone over the BoB and it's landfall over different coasts (like Bangladesh, Myanmar, and Andaman & Nicobar Islands). It was a challenge to predict the place and occurrence of LPA and it's possible intensification into a depression, it's further intensification into cyclone and movement towards a particular coast. Also, the translational speed of Amphan varied greatly and determination of landfall time correctly was a difficult task. IMD usually examines about 12 global and regional models including six models run by Ministry of Earth Sciences and six international models. There was large spread in model guidance even two days before the landfall. Even during the night before landfall day, i.e., during night of 19 May 2020, a few models were suggesting landfall over Odisha-West Bengal border around noon of 20 May 2020. Thus, predicting the landfall point correctly was not easy. Amphan underwent rapid intensification from 17th noon (1130 hrs IST) to 19th early morning (0230 hrs IST) with an increase in wind speed 2.3 times during this period. But, with the technological intervention and utilization of knowledge, experience and expertise, IMD provided timely and accurate cyclone warning to disaster managers, media and general public to manage the cyclone, Amphan like many intense cyclones in recent years including Phailin in 2013, Hudhud in 2014, Titli in 2018 and Fani in 2019.

9. OUTCOME OF COUNTDOWN MEASURES OF IMD WITH DM AUTHORITIES

IMD successfully monitored and predicted SuCS Amphan with a sufficient lead period and accuracy. There was almost zero error in landfall time and landfall point forecast upto 72 hrs ahead. The landfall point forecast errors for 24, 48 and 72 hrs lead period were 5.5, 11.0, and 35.2 km respectively against the last five years average errors of 44.7, 69.4 and 109.3 km during 2015-19, respectively. The landfall time forecast errors for 24, 48 and 72 hrs lead period were 0.5, 1.0, and 2.0 hours, respectively. Even the wind speed of the order of 100-110 gusting to 120 kmph and associated adverse weather for north Odisha coast and 155-165 kmph gusting to 185 kmph along and off West Bengal coast was also accurately predicted well in advance (RSMC New Delhi, 2020). Thus, IMD predicted accurately the genesis, the landfall point and the time, track, intensity, the associated adverse weather like wind, rainfall, storm surge associated with Amphan as well as expected damage. Its suggested actions also enabled disaster mangers to manage the cyclone effectively.

There has been a paradigm shift in the cyclone warning services of IMD during the last 10 years. There has been reduction in track forecast errors from 181 km (2009) to 69 km (2019) for 24hrs, and 483 km (2009) to 149 km (2019) for 72hrs forecast [RSMC, 2010 and 2020]. The forecasting services of IMD are at par with or better than other international centers. There has been a significant reduction in loss of lives and damage due to TCs on account the effective early warning systems apart from preparedness and mitigation measures of government.

10. CONCLUSIONS

It is always a fight against time during a cyclone to provide an early warning to disaster management agencies for effective management. Various countdown steps followed in the monitoring of a cyclone as per the SOP help the forecasters to proceed systematically in generating an effective and timely forecast. IMD continuously expands its observational network and enhances its modeling capabilities, generation of bulletins & warning graphics and communication network. Despite all challenges, IMD has been able to limit death toll due to TCs to double digit and reduce expenditure towards payment of ex-gratia to kins of dead, cost towards evacuation, etc., through accurate forecast with sufficient lead time. IMD has earned worldwide accolades for accurate forecast of TCs during recent years.

References

1. Dube,S.K., Rao,A.D., Poulose,J., Mohapatra,M., and Murty,T.S., (2013), "Storm surge inundation in south Asia under climate change scenario," *Monitoring and Prediction of Tropical Cyclones over Indian Ocean and Climate Change,*

Editors Mohanty,U.C., Mohapatra,M., Singh,O.P., Bandyopadhyay,B.K., and Rathore,L.S., Co-published by Capital Publishers, New Delhi and Springer, Germany

2. IMD, (2003), *Cyclone Manual*, India Meteorological Department, New Delhi
3. IMD, (2008), "Track of Storm and Depressions over the Indian Seas during 1891-2007", *Cyclone eAtlas of IMD*, India Meteorological Department, New Delhi
4. IMD, (2013), *Cyclone Warning Services: Standard Operation Procedure*, Cyclone Warning Division, India Meteorological Department, New Delhi
5. Julian,H., Prates,F., Bender,M., Cangialosi,J., Caroff,P., Doyle,J., Dube,A., Faure,G., Howell,B., Igarashi,Y., McTaggart-Cowan,R., Mohapatra,M., Moskaitis,J., Murtha,J., Rivett,R., Sharma,M., Short,C., Singh,A., Tallapragada,V., Titley,H., Xiao,Y., (2018), "Review of Recent Progress in Tropical Cyclone Track Forecasting and Expression of Uncertainties," Tropical Cyclone Research and Review, 8(4), 181-218
6. Mohapatra,M., Mandal,G.S., Bandyopadhyay,B.K., Tyagi,A., and Mohanty,U.C., (2012), "Classification of Cyclone Hazard Prone Districts of India," *Natural Hazards*, 63(3), 1601-1620, DOI:10.1007/s11069-011-9891-8
7. Mohapatra,M., Sikka,D.R., Bandyopadhyay,B.K., and Tyagi,A., (2013a), "Outcomes and Challenges of Forecast Demonstration Project (FDP) on Land-falling Cyclones over Bay of Bengal," *Mausam*, 61(1), 01-12
8. Mohapatra,M., Nayak,D.P., Sharma,R.P., and Bandyopadhyay,B.K., (2013b), "Evaluation of Official Tropical Cyclone Track Forecast over north Indian Ocean issued by India Meteorological Department," *Journal of Earth System Science*, 122(3), 589-601, DOI:10.1007/s12040-013-0291-1
9. Mohapatra,M., Bandyopadhyay,B.K., and Nayak,D.P., (2013c), "Evaluation of Operational Tropical Cyclone Intensity Forecasts over north Indian Ocean issued by India Meteorological Department," *Natural Hazards*, 68(2), 433-451, DOI:10.1007/s11069-013-0624-z
10. Mohapatra,M., Nayak,D.P., Sharma,M., Sharma,R.P., and Bandyopadhyay,B.K., (2015), "Evaluation of Official Tropical Cyclone Landfall Forecast issued by India Meteorological Department," *Journal of Earth System Science*, 124(4), 861-874; DOI:10.1007/s12040-015-0581-x
11. Mohapatra,M., (2015a), "Cyclone Hazard Proneness of Districts of India", *Journal of Earth System Science*, 124, 3, 515-526, doi:10.1007/s12040-015-0556-y

12. Mohapatra,M., (2015b), “Tropical Cyclone Forecast Verification by India Meteorological Department for North Indian Ocean: a review,” *Tropical Cyclone Research and Review*, 3, 1-14
13. Mohapatra,M., and Sharma,M., (2015), “Characteristics of Surface Wind Structure of Tropical Cyclones over the North Indian Ocean”, *Journal of Earth System Science*, 124 (7), 1573-1598. doi:10.1007/s12040-015-0613-6
14. Mohapatra,M., and Sharma,M., (2019), “Cyclone Warning Services in India during recent years: A review,” Mausam, 70(4), 635-666, October, 2019
15. Raghavan,S., (2013), “Observational Aspects including Weather Radar for Tropical Cyclone Monitoring”, *Mausam*, 64, 89-96
16. RSMC, (2010), *Report on Cyclonic Disturbances over North Indian Ocean during 2009*, Cyclone Warning Division India Meteorological Department, New Delhi
17. RSMC, (2020a), *Report on Cyclonic Disturbances over North Indian Ocean during 2019*, Cyclone Warning Division India Meteorological Department, New Delhi
18. RSMC, (2020b), *Preliminary Report on Super Cyclonic Storm Amphan*, www.rsmcnewdelhi.imd.gov.in
19. Sharma,M, and Mohapatra,M., (2017), “Standard Operation Procedure for Tropical Cyclone Vital Parameters over North Indian Ocean,” *Tropical Cyclone Activity over the North Indian Ocean*, Editors M.Mohapatra, Bandyopadhyay,B.K., and Rathore,L.S., Co-published by Capital Publishers, New Delhi and Springer, Germany, 367-381
20. WMO, (2016), *Tropical Cyclone Operation Plan 21*, 2016 Edition, WMO/TD No.84

Rakesh Kumar Sharma & Kunal Sharma

Preventing Chemical, Biological, Radiological and Nuclear Disaster

Abstract: The purpose of this review is twofold. First, it provides a better understanding of the national guidelines to mitigate CBRN emergencies. The second purpose is to provide a preparedness response strategy in CBRN events. Admittedly, it is beyond the scope of this paper to provide a detailed preventive mechanism for every possible CBRN event. This paper provides the basic elements enshrined in the NDMA's CBRN guidelines to provide proper strategy to prevent and mitigate CBRN disasters.

Key words: CBRN, Threat, WMD, Prevention, Risk Reduction, Surveillance, Contingency Planning

1. INTRODUCTION

Disasters involving Chemical, Biological, Radiological, and Nuclear (CBRN) materials cause severe damage to lives, property and the environment, and thereby adversely affect the very foundation of humanity and sustainable development. Threats related to CBRN use are evolving rapidly on account of fast technology developments and the changing political milieu. Preparing India to address the threat of CBRN is a formidable challenge because anticipating such attacks and dealing with the shattering consequences of the CBRN agents involved, are difficult and complex propositions. Major prevention measures include stricter techno-legal regimes, and deterrence of proliferation, capability development & deployment. With the increase in the likelihood of the CBRN confrontations, the need to raise medical preparedness in particular is far greater today than ever before. Utilization of information, knowledge, professional experience, and abilities is one approach to ensuring a high degree of expertise and competence in the CBRN area. The exchange of information on the national spectrum may include emergency response plans, gained experiences from exercises, research results regarding CBRN agents, CBRN detection methods, knowledge regarding forensic awareness at crime scenes, and improved analysis methods of forensic evidence.

CBRN substances have a wide range of hazardous effects, such as combustibility, corrosiveness, or associated toxicity, etc. [Sharma, 2010; Bland, 2006] explained CBRN incidents as those incidents that cause injury or illness to living organisms triggering into mass casualty events. They also have the potentiality to damage / disrupt the environment. CBRN disasters include issues of chemical and biological terrorism including those emanating as secondary disasters [Salem, 2003]. Approaches are described to brave the challenges of CBRN from the Occupational Health point in literature [Bobetich, 2005]. CBRN emergencies may result in occupational exposure, fire, explosion, release of toxicants. CBRN disasters are caused either by ignorance, negligence, incompetence, accident, malicious intention or deliberately as in Warfare. There is an imperative threat from a variety of CBRN agents that can be used to kill or incapacitate the military/paramilitary forces and the undefended civilian targets with associated consequences on livestock, crops, water bodies, military assets and civilian structures including environment. CBRN threats are no longer hype or horror, but a stern reality throughout the world. India being no exception is equally prone to CBRN emergencies.

2. CBRN THREAT PERCEPTION AND CHALLENGES

A summary of the CBRN threat matrix is schematically presented in **Figure 1**. It is pertinent to mention that naturally occurring biological hazards also include emerging and reemerging infectious diseases. Moreover, the intentional use of micro-organisms (either natural or genetically modified) or toxins derived from living organisms has been used to produce death or disease in humans, animals, or plants [Cieslak *et al*, 2018]. Toxins can be classified both in Chemical Warfare agents as well as Biological Warfare agents categories owing to their hybrid nature.

Threat perception is further compounded by activities of hostile countries, non-state actors, and terrorists. Another dimension is state-sponsored assassination or attempted assassination using CBRN agents. CBRN Weaponry is going to be the ultimate weapon in the terrorist's arsenal. Alexander and Klein (2006) elaborated the challenges for preparation for a chemical, biological, radiological or nuclear terrorist attack. The emergence of state-sponsored terrorism, proliferation of CBRN weapons & their means of delivery, and recent increases in less discriminate attacks, all point toward a growing probability of occurrence of mass casualty incident triggered by CBRN materials.

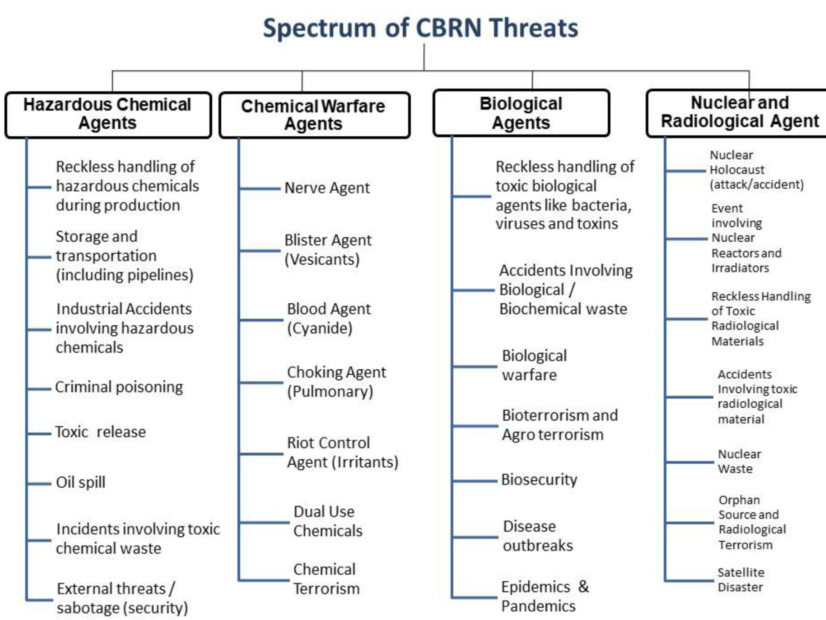

Figure 1: Possible CBRN Threats in India

The terrorist's intention in use of Weapons for Mass Destruction (WMD) will be to create both mass casualties as well as impact the society by causing mass disruptions [Cavallini *et al*, 2014].

Thus, CBRN threats are no longer a hype or myth but are real and imminent, rather a stern reality today. The CBRN threat perception settings are evolving at a very fast pace. But, it must be remembered that both predictable surprises and improbable scenarios are likely to emerge every time. This is precisely the reason why even the most meticulous planning may fail in real-time situations.

The National Policy on Disaster Management 2009 aims to prevent CBRN disaster from occurring at the first instant. But, in the event of unfortunate occurrences, various stakeholders shall undertake certain pre-planned and established Structural and Non-structural measures so as to mitigate the incidence and limit its consequences to health, life and environment. The degraded environmental resources are responded to, remediated and restored. Collaborative efforts will be needed to mitigate the potential impact of their mass casualty incidences wherein, the biggest challenges will be overwhelming of resources and stretching national capacities to their maximum extent followed by rehabilitation and recovery issues.

3. A BRIEF HISTORY OF MAJOR CBRN DISASTERS

Chemical attacks were extensively used in 1915. After World War I, new agents that were more lethal and potent than previously used chemicals were developed as Chemical Warfare agents. Second World War ended after nuclear attacks over the cities of Japan, *i.e.,* Nagasaki & Hiroshima on 6th and 9th August 1945, respectively. On 2nd December 1984, the biggest chemical accident happened in Bhopal, India, wherein approximately 40 tonnes of methylisocyanate (MIC) got released, exposing more than 5,00,000 people [Broughton, 2005]. Review studies indicate human health effects that resulted from exposure to emitted gases [e.g., Dhara and Dhara, 2002].

The Chernobyl disaster was a nuclear power plant accident that occurred on 26th April 1986, at the No.4 nuclear reactor in Plant, near the city of Pripet in the Soviet Union [Bonte, 2018]. It was classified as *Level 7* on 'The International Nuclear and Radiological Event Scale (INES).' The nuclear accident at the Fukushima Daiichi Nuclear Power plant in Okuma, Fukushima Prefecture in Japan that occurred on 11th March 2011 was a consequence of an earthquake of magnitude 9.0 on a Richter scale that generated ~14m high tsunami. All three cores largely melted in the first three days. This accident also received a Level 7 rating on the INES, due to high radioactive releases. A comparison of the Chernobyl and Fukushima nuclear accidents and review of the environmental impacts of nuclear incidents is available in literature [Steinhauser, 2013].

Chemical weapons are banned under customary international law, the 1925 Geneva Protocol and the 1997 Chemical Weapons Convention (CWC). But, Chemical weapons have been allegedly used extensively in Syria since 2013 by both state and non-state actors [Trapp, 2017].

H1N1 virus triggered pandemic flu in January 2009. This perilous swine flu pandemic lasted for about 19 months, and was the second of two pandemics involving an influenza virus (Spanish flu pandemic was the first). We are presently witnessing the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV2) and the associated Coronavirus Disease (COVID 19) (declared global pandemic on 11th March 2020 by WHO). COVID has been stressing the public health infrastructure and economies all around the world and disrupted various contours of our personal and professional life [Gennaro, 2020].

India is aiming to develop a dynamic action plan to reduce risk, improve mitigation strategies, conserve the environment and continue pursuing sustainable existences based on the good practices and lessons gleaned from aforementioned major CBRN disasters

4. CBRN TECHNO-LEGAL REGIMES

The Disaster Management Act (DM Act,2005), received the assent of The President of India on 23 December 2005. Incidents involving CBRN agents are labeled as *Level 3* (L3) Disasters irrespective of their severity, size, location, actual or potential impact on public health, welfare, and infrastructure. Ministry of Home Affairs is the nodal ministry for Disaster Management and Terrorism. Ministries of Environment, Forest and Climate Change; Health and Family Welfare; and Atomic Energy Commission, are the designated nodal ministries for Chemical, Biological, and Radiological & Nuclear Disasters, respectively.

4.1 National Disaster Management Authority Guidelines on CBRN Disasters

The National Disaster Management Authority (NDMA), India established under the DM Act, 2005, has issued various guidelines to enhance preparedness to protect its population against CBRN risks. The 'National Disaster Management Guidelines' directly or indirectly related to CBRN Disasters are as follows:

(1) Chemical (Industrial) Disaster Management. ISBN 978-81-906483-6-3, April 2007, New Delhi

(2) Medical Preparedness and Mass Casualty Management. ISBN 978-81-906483-6-3, October 2007, New Delhi

(3) Pandemic Preparedness beyond Health. ISBN 978-81-906483-6-3, April 2008, New Delhi

(4) Management of Biological Disasters. ISBN 978-81-906483-6-3, July 2008, New Delhi

(5) Management of Nuclear and Radiological Emergencies February 2009, New Delhi. ISBN 978-81-906483-7-0, February 2009, New Delhi

(6) Management of Chemical (Terrorism) Disasters. ISBN 978-81-906483-6-3, June 2009, New Delhi

(7) Psychosocial Support and Mental Health Services. December 2009, New Delhi

(8) Minimum Standards Relief (Shelter, Food, Drinking Water, Medical Cover and Sanitation).2010, New Delhi

These national documents call for a practical, participatory, understandable multi-disciplinary and multi-sectoral approach involving all stakeholder clusters, aimed at refining and strengthening the national mechanisms in this field, from stages of planning to field operations. These guidelines contain all details required by the planners and implementers.

4.2 List of Important Legislations and Rules related to CBRN

There exist a number of administrative, regulatory and legal arrangements in India for CBRN risk management including prevention, control, response and mitigation. A summary of CBRN Relevant Statutes is given in the following paragraphs. Public Health Emergencies Act (Draft) being drafted by MoHF&W intends to replace the Epidemic diseases Act, 1897, and provides for effective management of public health emergencies including bio terrorism.

4.2.1 Chemical Disasters

(1) The Environment (Protection) Act, 1986 (amended 1991), and the following Rules thereunder:

- (a) The Environment (Protection) Rules, 1986 (amended 2004).
- (b) The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (amended, 1994 and 2000).
- (c) The Hazardous Wastes (Management and Handling) Rules, 1989 (amended 2000 and 2003).
- (d) The Hazardous Waste (Management, Handling and transboundary Movement) Rules, 2008
- (e) The Environment Impact Assessment Notification, 2006.
- (f) The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996.
- (g) The Environment Impact Assessment Notification, 2006
- (h) Bio-medical Wastes (Management and Handling) Rules, 1998 (amended 2000)

(2) The Factories Act, 1948 (amended 1987)

- (a) State Factory Rules

(3) The Inflammable Substances Act, 1952

(4) The Motor Vehicles Act, 1988 (amended 2001, 2019)

- (a) The Central Motor Vehicles Rules, 1989 (amended 2005, 2019)

(5) The Public Liability Insurance Act, 1991 (amended 1992)
    (a) The Public Liability Insurance Rules, 1991 (amended 1993)
(6) The Petroleum Act, 1934
    (a) The Petroleum Rules, 2002
(7) The Insecticide Act, 1968 (amended 2000)
    (a) The Insecticide Rules, 1971 (amended 1999)
(8) The National Environment Tribunal Act, 1995
(9) The Explosives Act, 1884 (amended till 1983)
    (a) The Gas Cylinder Rules, 2004
    (b) The Static and Mobile Pressure Vessels (Unfired) Rules, 1981 (amended 2002)
    (c) The Explosives Rules, 1983 (amended 2002)
(10) The Drugs and Cosmetics Act, 1940 and various Rules framed thereunder
(11) The Poison Act, 1919
(12) The Weapons of Mass Destruction and their Delivery Systems (Prohibition of Unlawful Activities) Act, 2005
(13) The Defence of India Act, 1971 and the Rules framed thereunder
(14) The Civil Defence Act, 1968
(15) The Water (Prevention and Control of Pollution) Act, 1974 and Rules, 1975
(16) The Air (Prevention and Control of Pollution) Act, 1981 and Rules, 1983
(17) The Chemical Weapons Convention (CWC) Act, 2000
(18) Weapon of Mass Destruction Act, 2005

4.2.2 Biological Disasters

(1) Epidemic Diseases Act, 1897
(2) Water (Prevention and control of pollution) Act, 1974 and the Rules 1975

(3) The Air (Prevention and Control of Pollution) Act, 1981 and the rules, 1983

(4) The Environmental Protection Act 1986 and the rules, 1986

    (a) The Manufacture, Use, Import, Export & Storage of Hazardous Micro Organisms Genetically Engineered Organisms or Cells Rules, 1989

    (b) Bio-Medical Waste (Management and Handling) Rules, 1998

(5) The Biological Diversity Act, 2002

    (a) Cartagena Protocol on Biosafety to the Convention on Biological Diversity, 2003

(6) Weapon of Mass Destruction Act, 2005

4.2.3 Nuclear and Radiological Emergencies

(1) Atomic Energy Act, 1962

    (a) Radiation Protection Rules (2004)

    (b) Working of Mines, Minerals and Handling of Prescribed Substances Rules (1984)

    (c) Safe Disposal of Radioactive Wastes Rules (1987)

    (d) Control of Irradiation of Food Rules (1996)

    (e) Factories Rules (1996)

(2) The Civil Liability for Nuclear Damage Act, 2010

5. ARE CBRN DISASTERS PREVENTABLE

The disaster management framework in India has undergone a paradigm shift where the main thrust is on prevention. Prevention is a term that refers to the action of stopping something from happening or arising. The term CBRN includes measures to be deployed and actions that must be taken for preventing their occurrence and escalation. Prevention is the best way to achieve CBRN safety. Being fore-warned is being fore-armed is an age-old saying. Knowledge in advance enables one to be better prepared. The utility of the bio-surveillance portal and an international network of institutional analysts in detecting biological threats is recorded in literature [Riccardo et al, 2014].

CBRN Safety and protection must be seen as an integral part of everyday life. China points in national strategies to combat against emerging infectious diseases elaborated [Han*et al*, 2017]. The accidents or attacks involving CBRN agents may not be totally preventable but the incidences can be minimized by adopting stringent measures for safety & security, and mitigated by adopting a sound risk management framework based upon the risk and vulnerability assessment, surveillance and environmental monitoring.

6. CBRN NON-PROLIFERATION AS A PREVENTIVE MECHANISM

The sequel of CBRN disasters is so devastating that substantial emphasis is laid on their prevention in the form of loss of life, risks to human health, the environment (particularly vulnerable ecosystems) and economic assets. All attempts are made for preventing such Incidents and Accidents from escalating to a disaster. CBRN accident prevention involves decisions, planning and action to prevent accidents from happening.

Preventing CBRN materials from falling into the wrong hands is a complex challenge given that their dual-use nature that makes them relatively easy to obtain through the healthcare, research institutes and industrial sectors illicitly or by pilferage. United Nations Security Council Resolution (UNSCR) 1540 asserts that propagation of chemical, nuclear and biological weapons, as well as their means of release, constitutes a danger to international peace and security. India is signatory to a number of international arms control, nonproliferation treaties and conventions limiting proliferation of nuclear weapons and banning biological and chemical weapons altogether.

India is party to the Biological and Toxin Weapons Convention (BTWC 1972), Biological Weapon Convention (BWC 1972) and Chemical Weapons Convention (CWC 1993). Also, India has joined many protocols and agreements towards effective non-proliferation, CBRN counter terrorism, strategic trade control of dual use goods and hazardous waste management. As a signatory to BWC India "undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain: microbial or other biological agents, or toxins, whatever their source or production mechanism, of types and in quantities that have no explanation for prophylactic, protective or any other peaceful reasons; and weapons, equipment or means of release designed to use such toxins or agents for hostile intentions or in case of armed conflict. India has also signed and adopted International Health Regulations, IHR (2005) that seeks to protect against, control and provide a mechanism to initiate a public health response to the threat or spread of disease causing Public Health Emergency of International Concern (PHEIC) including that of biological, chemical or radio-nuclear origin.

7. VULNERABILITY ANALYSIS AND RISK ASSESSMENT

Vulnerability analysis and risk assessment needs to be carried out so that appropriate preventive strategies and preparedness measures are instituted appropriately. Integrated Disease Surveillance Systems (IDSP) should aim to perform real-time monitoring to detect early warning signals for instituting appropriate public health measures. Suitable assessment of the personnel, security, specific training and rigorous adherence to pathogen protection procedures are reasonable means of enhancing bio-security. India needs to maintain epidemiological intelligence to pick up early warning signals of emerging and re-emerging diseases of epidemic potential. Counter-terrorism strategies include collection of CBRN surveillance data that can detect early warning signs, environmental monitoring, and risk and vulnerability assessments. Pharmaceutical Interventions (like Chemoprophylaxis), Pre-exposure Immunization (preventive) of first responders and other preventive measures must be taken to enable them to help victims post-exposure. Environmental impact assessment of accidental or intentional releases of potentially hazardous materials in the atmosphere is increasingly supported by the development of modeling tools. This helps in risk zonation at the micro level by employing database management, and synergizing cooperation between various intelligence agencies. An efficient mechanism needs to be devised to monitor and inspect the stockpiling and transportation of CBRN material. Surveillance at port of entries need be strengthened with appropriate controls. The current COVID-19 outbreak reminds the world about our vulnerability to the deadly CBRN hazards. Non-pharmaceutical interventions (like Social Distancing Measures to reduce direct contact with the affected persons) can delay the onset, compress the epidemic curve and spread it over a longer time, thus reducing the overall health impact. The spread of communicable diseases in many conditions can be controlled or prevented by isolation (home/hospital), quarantine (restrictions in the movement of the affected persons) and containment. The present COVID 19 situation has already put a big question mark on our strategic preparedness.

8. RISK REDUCTION

Risk reduction by prevention/mitigation including minimizing and eliminating risks, is key to pursuing the safe management of CBRN agents. Risk Reduction and Mitigation are important components of the holistic approach to disaster management. Risk Reduction implies dealing with root causes in order to reduce the total risk and lessen the likelihood. Risk Mitigation denotes building capacities to contain damage & reduce the consequences.

The most effective preventive step to deter a CBRN incident is to deny CBRN acquisition or capability development. Easy availability of CBRN agents and scientific weapons expertise, increasing knowledge about genome, virulence etc., in open public domain on the internet, poses a big challenge for preventing CBRN incidents. The internet has a big role in facilitating the malicious use of CBRN materials.

The CBRN Terrorism Threats Risk Reduction Framework includes measures to: (a) dissuade malicious actors; (b) deny material, equipment and expertise; (c) deter (counter-terrorism like epidemiological intelligence gathering mechanism or environmental surveys of chemicals/radioactivity to deter a terrorist attack); (d) detect illicit activities like covert CBRN program, and (e) defend against CBRN attacks with effective consequence management and attribution. Appropriate financial strategies should be put in place to scuttle their flow of funds.

This will ensure that access to technology, materials, and capability, is greatly reduced. These measures are aimed to preventing and impeding predominantly State actors to acquire or attain capabilities of developing CBRN materials (Proliferation Prevention), to frustrate development of CBRN capabilities by potential actors (Actor-Capability Development Prevention), and to stop or defeat a CBRN device before its actual deployment. An illustration about protecting critical national assets and preparedness for response to hazardous chemical, biological and radiological attacks has been published recently [Sharma *et al*, 2019].

9. CONCLUSION

Integrating prevention & protection against CBRN disasters through the deployment of monitoring and surveillance systems, raising preparedness, honing skills for mitigation, capacity development and training, are the keys for safer world and safer India.

References

1. Alexander,D.A., and Klein,S., (2006), "The challenge of preparation for a chemical, biological, radiological or nuclear terrorist attack," J. Postgrad. Med., 52(2):126-31, PMID: 16679677
2. Bland,S.A., (2006), "Chemical, biological, radiation and nuclear (CBRN) incidents," J. R Army Med Corps, 152, (4):244-9, DOI: 10.1136/jramc-152-04-11
3. Bobetich,K., (2005), "Braving the challenge of CBRN," Occup. Health Saf., 74(11):38
4. Bonte,F.J., (1988), "Chernobyl retrospective," S. Nucl Med., 18(1):16-24,

   DOI: 10.1016/s0001-2998(88)80016-3
5. Broughton,E., (2005), "The Bhopal disaster and its aftermath: a review," Environ. Health, 4 (1), p 6
6. Cavallini,S., Bisogni,F., and Mastroianni,M., (2014), "Economic impact profiling of CBRN events: focusing on biological incidents," Arch. Immunol. Ther. Exp. (Warsz), 62(6), 437-44, DOI: 10.1007/s00005-014-0306-x

7. Cieslak,T.J., Kortepeter,M.G., Wojtyk,R.J., Jansen,H.J., Reyes,R.A., and Smith,J.O., (2018), "Beyond the Dirty Dozen : A Proposed Methodology for Assessing Future Bioweapon Threats," NATO Biological Medical Advisory Panel, Mil. Med. 1, 183(1-2):e59-e65, DOI: 10.1093/milmed/usx004

8. Dhara,V.R., and Dhara,R., (2002), "The Union Carbide disaster in Bhopal: a review of health effects," Arch Environ Health, 57(5):391-404,

   DOI: 10.1080/00039890209601427

9. Gennaro,F.D., Pizzol,D., Marotta,C., Antunes,M., Racalbuto,V., Veronese,N., and Smith,L., (2020), "Corona-virus Diseases (COVID-19) Current Status and Future Perspectives: A Narrative Review," Int. J. Environ. Res. Public Health, 17(8),

   doi.org/10.3390/ijerph17082690

10. Han,M., Gu,J., Gao,G.F., and Liu,W.J., (2017), "China in action: national strategies to combat against emerging infectious diseases," Sci. China Life Sci., 60, 1383-1385

11. Riccardo,F., Shigematsu,M., Chow,C., McKnight,C.J., Linge,J., Doherty,B., Dente,M.G., Declich,S., Barker,M., Barboza,P., Vaillant,L., Donachie,A., Mawudeku,A., Blench,M., and Arthur,R., (2014), "Interfacing a bio-surveillance portal and an international network of institutional analysts to detect biological threats," Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science, 12(6):325-36, DOI: 10.1089/bsp.2014.0031

12. Salem,H., (2003), "Issues in chemical and biological terrorism," Int J. Toxicol., (6):465-71, DOI: 10.1177/109158180302200607

13. Sharma,R.K., (2010), "CBRN Disasters: Pitfalls and Perils," J. Pharm Bioall Sci, 2(3), 155-156, DOI: 10.4103/0975-7406.68490

14. Sharma,R.K., Rana,S., and Gopalan,N., (2019), "Towards Protecting Critical National Assets and Preparedness for Response to Hazardous Chemical, Biological and Radiological Attacks," Defence Life Science Journal, 4(4), 256-265, DOI: 10.14429/dlsj.4.15134

15. Steinhauser,G., Brandl,A., and Johnson,T.E., (2014), "Comparison of the Chernobyl and Fukushima nuclear accidents: a review of the environmental impacts," Sci. Total Environ., 470-471:800-17, DOI: 10.1016/j.scitotenv.2013.10.029, ePub 2 November 2013

16. Trapp,R., (2017), "The Use of Chemical Weapons in Syria: Implications and Consequences," Chapter in Friedrich,B., Hoffmann,D., Renn,J., Schmaltz,F., Wolf,M., (Eds.), *One Hundred Years of Chemical Warfare: Research, Deployment, Consequences*, Springer, Cham, https://doi.org/10.1007/978-3-319-51664-6_19

Devi Prasad Juvvadi & G. Kiran Kumar

Understanding Droughts

Abstract: Drought is a complex phenomenon and one of the most challenging disasters to predict and manage. Reduction of vulnerabilities and improvement of response capacities is key objective of an early warning system. Multiple physical indicators and climatic indices along with social indicators need to be incorporated in early warning systems. Developing a drought policy is crucial to drought management. D rought mitigation measures are typically non-structural and are not visible to most people. Development of preparedness plans and implementation of drought policies attempt to create institutional capacity. Integration of environmental forensic techniques into drought management provides better drought management solutions.

Key words: Droughts, Early warning systems, Drought preparedness, Comprehensive drought policy, Sustainable drought management strategy.

1. INTRODUCTION

Among the weather-related natural disasters drought is probably the most complex and severe on account of its intrinsic nature and wide ranging and cascading impacts that affect several sectors including agricultural production, public water supply, energy production, transportation, tourism, human health, biodiversity and natural ecosystems. Droughts are recurrent, can last from a few weeks to several years, and affect large areas and populations around the globe every year. The impacts of drought develop slowly, are non-structural, often indirect and can linger for long times after the end of the drought itself. While the impacts result in severe economic losses, environmental damage and human suffering, they are in general less visible than impacts of other natural hazards (*e.g.,* floods, storms) that cause immediate and structural damages, which are clearly linked to the hazard and quantifiable in economic terms [UNISDR, 2011]. Drought risk, therefore, is often underestimated. While the need for pro-active drought management has been recognized, its implementation is still lagging behind resulting in long lasting negative consequences, in particular in the poor developing countries. They have become a limiting factor to economic and social development. Various efforts have been set out for the establishment of appropriate prevention and management measures to cope with this problem [Budhakooncharoen, 2003]. This paper presents a study on a comprehensive disaster risk management to relieve drought stress in such a way so as to avoid past mistakes and which results in satisfying a wide range of needs including agriculture, irrigation and maintenance of the natural ecosystem.

2. DEFINING DROUGHT

A drought is an arid period with less rainfall occurring than is the usual case, or even, no rainfall. It occurs whenever the groundwater level and river flow decrease and a water shortage for human, industry, service, and agricultural uses occurs. It can be classified into 3 types, namely:

(a) *Meteorological drought*, involving evaporation from the soil and plants is more than the annual rainfall;

(b) *Hydrological drought*, which is characterized by a meteorological phenomenal change with prolonged period with only a small quantity of average rainfall intensity-groundwater and river water levels remain low causing a lack of water during the dry season; and

(c) *Agriculture drought*, involving the situation of water shortage for agriculture which may occasionally occur in the early rainy season and widely causes a destruction of agriculture.

Drought is one of the most common natural disasters, and often causes significant environmental, agricultural, healthy, economic and social consequences, especially in developing economies. As for scientists and researchers, detecting the occurrence and severity of the drought disaster by observing the spatio-temporal changes of nature is an important challenge. In this field, meteorologists, hydrologists, geophysicists proposed many methods and models from different perspectives. Droughts can be summarized into three categories: meteorological indexes (*e.g.,* the Standardized Precipitation Index), process-based indexes (*e.g.,* evaporative fraction) and satellite-based indexes (*e.g.,* vegetation indexes) [Su *et al*, 2003]. All of the above indexes are composed of geophysical parameters, *e.g.,* land surface temperature, soil moisture, vegetation water content, and surface albedo. Therefore, the measurement of geophysical parameters largely determines the precision and accuracy of monitoring [Dong *et al*, 2017].

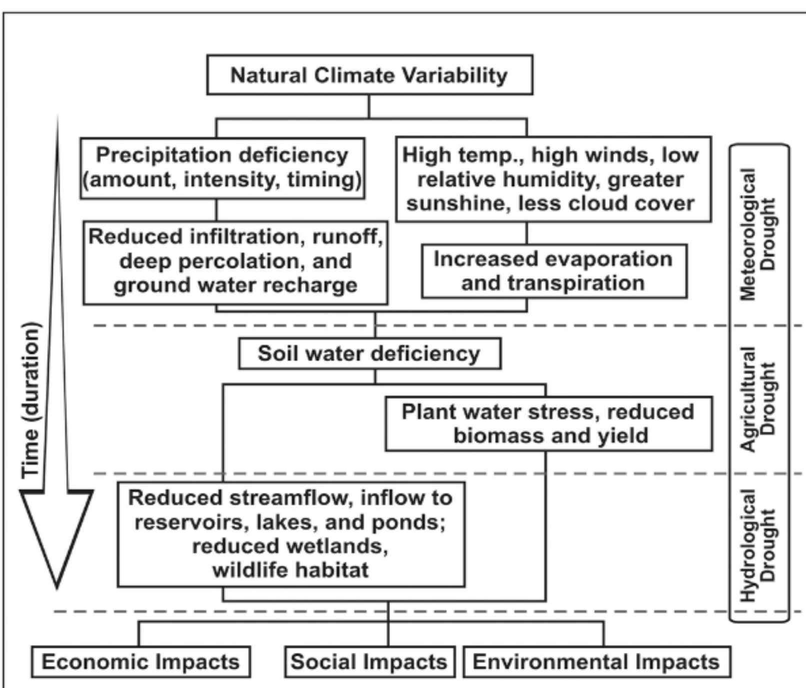

Figure 1: Drought types, causal factors and their usual sequence of occurrence [Source: National Drought Mitigation Center University of Nebraska-Lincoln, USA]

3. FORECASTING AND MONITORING DROUGHT

The basic problem is that drought measurement and forecasting is traditionally the domain of meteorologists and hydrologists, who do not consider the real impacts of drought on people and the environment. Analysing research to improve drought monitoring is particularly challenging because drought represents a combination of numerous geophysical phenomena, and the monitoring and management of drought involves a synthesis of disparate information sources whose characteristics vary. This variability in information includes time, space, quality, format, availability, and in relative importance depending on the objectives and perspectives of users in different drought-affected sectors. Traditional measurements of geophysical parameters are point-based, which mainly rely on fixed or mobile stations. The interpolation methods and the representativeness of the observation points have been discussed a lot to extend the point-based observations to continuous data. The rapid development of remote sensing technology in recent decades provides an effective solution to this problem and the satellite-based drought indexes have attracted scholars' attentions. Many effective models were proposed based on different ranges of electromagnetic spectrum to accommodate various kinds of underlying surface conditions. For instance, the thermal inertia model and the active microwave remote sensing model were designed to monitor the drought over bare soils. For vegetated surfaces, the Crop Water Stress Index, the Temperature Vegetation Dryness Index, the Perpendicular Drought Index , the Shortwave Infrared Perpendicular Water Stress Index have been widely used to monitor the drought status of the soil with different vegetation coverage. The continuous modification of the existing drought indexes and the continuous advent of new indexes are the inevitable trend of drought monitoring using remote sensing technology. Therefore, the drought monitoring systems which implement those indexes are becoming increasingly important.

The software platform is fundamental to drought monitoring services. The government agencies or organizations in many countries established drought monitoring platforms in succession, including US Drought Monitor [USDM, http://droughtmonitor.unl.edu], European Drought Observatory [EDO, edo.jrc.ec.europa.eu], Meteorological Drought Monitoring System of China [MDMSC, http://cmdp.ncc-cma.net/influ/dust.php], and African Flood and Drought Monitor [AFDM, http://stream.princeton.edu/AWCM/WEBPAGE/interface.php]. A few scholars and research teams also developed drought monitoring and publishing systems. Deng et al. built an on-demand web service system named Global Agriculture Drought Monitoring and Forecasting System (GADMFS), which significantly improves global agriculture drought monitoring, prediction and analysis. A Global Integrated Drought Monitoring and Prediction System (GIDMaPS) was prepared [Hao *et al*, 2014], which provides meteorological and agricultural drought information based on multiple satellite-based and model-based precipitation and soil moisture datasets. A drought monitoring and seasonal hydrological forecast system was developed for sub-Saharan Africa contributes to building capacity through technology and knowledge transfer [Sheffield *et al*, 2014].

Although great progress has been made in drought monitoring technology, there are still work to do on the development of software and platforms. On the one hand, the current drought related platforms are often designed for a single purpose and focus mainly on information management and publishing, which cannot satisfy the advanced needs in research and professional work. And, on the other hand, the existing powerful remote sensing image processing software such as Environment for Visualising Images (ENVI) provide no specific module for drought monitoring, which makes a variety of complex and diverse inversion models cannot be well applied, especially the models based on multi-dimensional feature space. Furthermore, the architecture of most existing software does not allow users to incorporate new or customized models. The above limitations hinder the use of remote sensing technology in drought monitoring. Therefore, in the community of remote sensing, there is a growing need for a professional drought monitoring system with high flexibility and extendibility [Dong *et al*, 2017].

Early warning systems (EWSs) aim to reduce vulnerability and improve response capacities of people at risk. Governments maintain EWSs to warn the citizens and themselves about impending hazards, resulting for example, from health, geologic or climate and weather-related drivers. Seasonality already provides decision makers with clear indications of regions that are potentially at risk. Decision-making quality depends in part on the information available and the manner in which this information is processed by individuals, groups and systems [ICSU, 2008]. The timing and form of climatic information inputs (including forecasts and projections), and access to trusted guidance and capability to interpret and implement the information and projections in decision-making pro-cesses, are as important to individual users as improvements in prediction skill [Pulwarty, 2007]. Numerous natural indicators of drought should be monitored routinely to determine drought onset, end, and spatial characteristics. Severity must also be evaluated continuously on frequent time steps. Although droughts originate from a deficiency of precipitation, it is inadequate to rely only on this climatic element to assess severity and resultant impacts. Effective drought early warning systems must integrate precipitation data with other data, such as stream flow, snow pack, ground water levels, reservoir and lake levels, and soil moisture in order to assess drought and water supply conditions. For most locations, drought forecasting and early warning is still a linear process based on a "sender–receiver" model of risk communication.

It is more effective to design Drought Early Warning and Information Systems (DEWIS) that rely on multiple physical indicators and climatic indices in combination with social indicators. Effective DEWIS are an integral part of efforts worldwide to improve drought management and prepared-ness and must be the foundation of mitigation plans and a national drought policy. Drought by itself does not trigger an emergency. Whether it becomes an emergency or disaster depends on its impact on local communities and the environment. And that, in turn, depends on the vulnerability of people and the environment to such a "shock". Drought results in substantial impacts in both developing and developed countries, although the characteristics of these impacts differ considerably. The ability to cope with drought also varies considerably from country to country and from one region, community, or population group to another. Assessments of DEWIS illustrate that the most successful:

(1) Integrate social vulnerability indicators with physical variables across timescales;

(2) Embrace risk communication as an interactive social process; and

(3) Support governance of a collaborative framework for early warning across spatial scales [Pulwarty and Verdin, 2013].

Monitoring coping responses, that is the sequential or hierarchical strategies that households use to fend off hunger and preserve their productive assets, is critical but still in its infancy primarily because local observers are needed to determine the meaning of scarcity responses. Thus, the governance context in which DEWIS are embedded is the key.

4. BUILDING SOCIETY RESILIENCE THROUGH NATIONAL DROUGHT POLICIES

Natural disasters are a consequence of the interactions between the weather and climate extremes and the vulnerability of human and natural ecosystems to such extremes. Research shows that the frequency and magnitude of extreme events is on the rise. According to WMO, the world experienced unprecedented high-impact climate extremes during the 2001–2010 decade, which was the warmest since the start of modern measurements in 1850 [WMO, 2013b]. The decade ending in 2010 was an unprecedented era of climate extremes, as evidenced by heat waves in Europe and Russia, droughts in the Amazon Basin, Australia, and East Africa, and huge storms, like Tropical Cyclone Nargis and Hurricane Katrina. Exposure and vulnerability to natural hazards is increasing as more people and physical assets are located in areas of high risk. According to the data provided by the Centre for Research on the Epidemiology of Disasters (CRED), during the decade 2001–2010, more than 3,70,000 people died as a result of extreme weather and climate conditions, including heat waves, cold spells, drought, storms, and floods. This was 20% higher than 1991–2000 [CCSP, 2008].

As drought is a slow-developing process, the people usually do not feel the response in comparison to mitigation measures for floods. Short-term measures would include providing early-warning information, increased emphasis on water conservation (demand reduction), increased water supplies through other backup resources such as groundwater and water reutilization and recycling. A short-term strategy like water recycling can immediately reduce the need of a water supply and the installation of a water recycling system can be done in a timely and cost-effective manner. But, a comprehensive plan and long-term measures are key to solving the drought issue fundamentally. Long-term measures include the construction of reservoirs and drought preparedness planning to build greater institutional capacity and awareness building and education. A comprehensive plan includes long-term measures to meet the long-term water demand along with short-term measures to provide a buffer to respond to the uncertainty of the future.

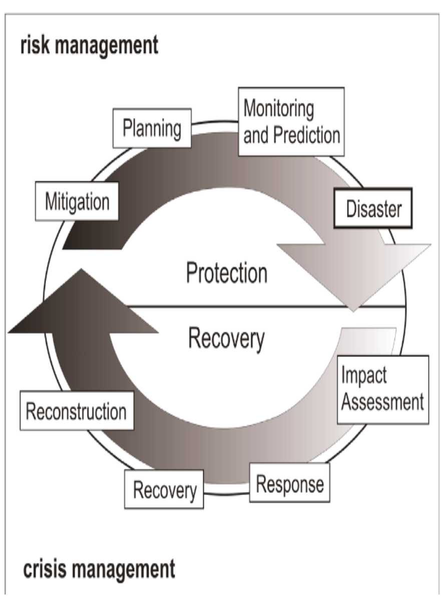

Figure 2: Cycle of Disaster Management

[Source: National Drought Mitigation Center, University of Nebraska-Lincoln, USA]

5. DEVELOPING A COMPREHENSIVE DROUGHT POLICY

As a beginning point in the discussion of national drought policy, it is important to identify the various types of drought policies that are available and have been utilized for drought management. The approach most often followed by both developing and developed nations is post-impact government (or non-government) interventions. These interventions are normally relief measures in the form of emergency assistance programs aimed at providing money or other specific types of assistance (*e.g.,* livestock feed, water, and food) to the victims (or those experiencing the most severe impacts) of the drought. This reactive approach is seriously flawed from the perspective of vulnerability reduction since the recipients of this assistance are not expected to change behaviours or resource management practices as a condition of the assistance. Although providing a safety net for those people or sectors most vulnerable to drought is a high priority, the challenge is to do it in a manner that reinforces the tenets of a drought risk reduction strategy. For example, livestock producers that do not maintain adequate on-farm storage of feed for livestock as a drought management strategy will be those that first experience the impacts of extended precipitation shortfalls. These producers will be the first that turn to the government or other organizations for assistance to maintain herds until the drought is over and feedstocks return to adequate levels. This reliance on the government for relief is contrary to the philosophy of encouraging self-reliance through producer investment in creating improved coping capacity. Government assistance or incentives that encourage these investments would be a philosophical change in how governments respond and would promote a change in the expectations of livestock producers as to the role of government in these response efforts.

The more traditional approach of providing relief also is flawed in terms of the timing of assistance being provided. It often takes weeks or months for assistance to be received, at times well beyond the window of when the relief would be of greatest value in addressing the impacts of drought. A second type of drought policy approach is the development of pre-impact government programs that are intended to reduce vulnerability and impacts. In the natural hazards field, these types of programs or measures are commonly referred to as mitigation measures. Mitigation in the context of natural hazards is different from mitigation in the context of climate change, where the focus is on reducing greenhouse gas (GHG) emissions. Drought mitigation measures are numerous but appear to be less obvious to many people, including policy makers, when associated with drought since impacts are generally non-structural. Mitigation measures for many other natural hazards (e.g., earthquakes, floods, hurricanes) are often largely structural. Drought mitigation measures would include establishing comprehensive early warning and information systems, improving seasonal forecasts, increasing emphasis on water conservation (demand reduction), increasing or augmenting water supplies through greater utilization of groundwater resources, constructing reservoirs, interconnecting water supplies between neighboring communities, drought planning, and awareness building and education. A more exhaustive list of these measures was compiled through a survey of states and other entities in the United States following several drought episodes in the late 1980s and early 1990s [Wilhite and Rhodes, 1993]. Insurance programs, currently available in many countries, would also fall into this category of policy types.

The final type of policy response is the development and implementation of preparedness plans and policies, which would include organizational frameworks and operational arrangements developed in advance of drought and maintained between drought episodes by government or other entities. This approach represents an attempt to create greater institutional capacity focused on improved coordination and collaboration within and between levels of government and with stakeholders in the plethora of private organizations with a vested interest in drought management (*i.e.,* communities, natural resource districts or managers, utilities, agribusiness, farm organizations, and others).

6. PROPOSED INNOVATIVE SUSTAINABLE DROUGHT MANAGEMENT STRATEGY

Environmental forensic techniques offer multiple cutting-edge tools that can be used to expedite restoration and reuse of contaminated water sources, evaluate water recharge areas and age, as well as predict areas more susceptible to droughts and prepare for "worst-case scenarios". While some of these techniques are used in water management, their combined use to provide tailored solutions for sustainable drought management has not been attempted to date based on the conducted review for this study. Therefore, the authors of this article propose the integration of environmental forensic techniques into drought management plans in order to provide effective and sustainable alternative strategies tailored to growing needs. As science evolves, improvement and new techniques become available for detailed environmental characterization and restoration. Their integration into routine drought management plans in synergy with other technologies and practices discussed, will provide solutions more fit to face the problems of tomorrow, including foreseeable severe and recurrent droughts events [Katyal and Petrisor, 2012].

7. CONCLUSION

Significant knowledge on reactive and anticipatory approaches to drought hazards and disasters has been derived over the past few decades. However, in an increasingly interconnected and rapidly changing world, several areas of concern for drought risk management are emerging [Vogt *et al*, 2018] and need to be considered in drought management. A sustainable future requires that humankind addresses the three pillars of sustainable development—environmental, social and economic. Earth's water supply is finite, so it is clear that we need to use what we have in a sustainable fashion. Yet, planning and decision-making are complex processes, given the countless demands for water for industry and households, sanitation systems and hydropower production, irrigation and drainage, and the needs of the aquatic ecosystems that supply it all to us. None of this can happen unless we have better assessments of the quantity and quality of available water resources. It is increasingly recognized that early warning and prediction systems for impending weather and climate hazards, with good lead-time, are key to ensuring food security. In mid-latitudes, weather can now be forecast for up to a week, but predicting the longer-term climate is a considerable advantage. Understanding El Niño is the first big breakthrough in our ability to do this. Coupling climate models with high-resolution regional models are providing climate outlooks for up to several seasons. It is now possible to predict El Niño-related anomalies in sea-surface temperatures up to a year in advance, as well as to provide early warning of phenomena associated with El Niño, such as unusual patterns of rainfall. The quest for sustainable development is long and complex. The World Meteorological Organisation (WMO) in 2004 proposed that development strategies and technologies must emerge which do not harm the environment or the climate and which include adaptation measures to help all countries, especially the developing ones, address the potential impacts of climate change.

References

1. Budhakooncharoen,S., (2003). *Floods and droughts: Sustainable Prevention and Management*, WIT Press, Southampton, UK

   doi:http://dx.doi.org/10.2495/ECO030412

2. Karl,T.R., Meehl,G.A., Miller,C.D., Hassol,S.J., Waple,A.M., and Murray,W.L. (2008), "Weather and Climate Extremes in a changing climate," **US Climate Change Science Program**

3. Dong,H., Li,J., Yuan,Y., Lin,Y., and Chen,C., (2017), "A component-based system for agricultural drought monitoring by remote sensing," PLoS One, 12(12) doi:http://dx.doi.org/10.1371/journal.pone.0188687

   https://library.wmo.int/doc_num.php?explnum_id=4540

4. Hao,Z., AghaKouchak,A., Nakhjiri,N., and Farahmand,A., (2014), "Global Integrated Drought Monitoring and Prediction System," **Scientific Data**, 1:140001: 1–10

5. ICSU, (2008), "Science Plan for Integrated Research on Disaster Risk: Addressing the Challenge of Natural and Human-Induced Environmental Hazards," International Council for Science, Paris

6. Katyal,A.K., and Petrisor,I.G., (2012), "Innovative Sustainable Drought Management Strategy Incorporating Forensic Techniques and Policy Framework," **Environmental Forensics**, 13:2, 122-139, DOI: 10.1080/15275922.2012.676605

7. Pulwarty,R., (2007), Communicating Agro-meteorological Information Including Forecasts for Agricultural Decisions, Guide to Agricultural Meteorological Practices. World Meteorological Organization, Geneva, Switzerland.

8. Pulwarty,R., and Verdin,J., (2013), " Crafting early warning information systems: the case of drought," *Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies*, Birkmann,J., (Ed.), Second Edition, United Nations University Press, pp. 124-147

9. Sheffield,J., Wood,E., Chaney,N., Guan,K.Y., Sadri,S., Yuan,X, (2014), "A Drought Monitoring and Forecasting System for Sub-Sahara African Water Resources and Food Security," **Bulletin of the American Meteorological Society**, Vol.95: 861–882

10. UNISDR, (2011), "Drought Risks," Chapter 3 in "Global Assessment Report on Disaster Risk Reduction. Revealing Risk, Redefining Development, GAR 2011," United Nations International Strategy for Disaster Reduction, 920110, pp 54-69

11. Vogt,J.V., Naumann,G., Masante,D., Spinoni,J., Cammalleri,C., Erian,W., Pischke,F., Pulwarty,R., and Barbosa,P., (2018), "Drought Risk Assessment: A conceptual Framework," EUR 29464 EN, Publications Office of the European Union, Luxembourg, 2018. ISBN 978-92-79-97469-4, doi:10.2760/057223, JRC113937

12. Wilhite,D.A., (2001), "Moving beyond crisis management," **Forum for Applied Research and Public Policy**, 16(1), 20-28,

https://search.proquest.com/docview/235133392?accountid=141248

13. Wilhite,D.A., and Rhodes,S.L., (1993), "Drought mitigation in the United States: Progress by state government," In Drought Assessment, Management and Planning: Theory and Case Studies, pp 237-251, Springer, Boston, MA.WMO, 2004

Vinod K. Sharma & Shyamli Singh

Challenges in Disaster Management in Hill Areas *A Case Study of Sikkim*

Abstract: Risks in Sikkim were mapped by a community-based approach. Data was collected through survey and analysis. Surveys were held through discussions in focus group in association with the Panchayats Raj Institutions (PRI). The Community Risk Registers (CRR) so developed were used for identifying and evaluating risks. The complex disasters analysed in four *Gram Panchayat Units* of Sikkim with issues related to climate change lead to establishment of DRR methods providing a local area plans resonating through all levels. This holistic approach desirable towards a disaster resilient and sustainable future is applicable for all the North-Eastern states in disaster risk reduction.

Key words: Disaster Risk Reduction, Complex Disasters, Community Risk Registers, Hilly areas.

1. INTRODUCTION

Rising trends in disasters indicate that more than one billion people in the world are exposed to disaster-induced risk. The major drivers of disasters are climate change and environmental dilapidation It has elements pertaining to severity, exposure and vulnerability [World Bank, 2005]. Cascading events are more impactful when resulting from multi-hazards and when landscaped in nature having upstream-downstream links. These are termed as complex disasters. One primary event triggers a chain of hazard events. Some major examples of such disasters are the flood in Alaknanda river in Uttarakhand in the year 1970; the Gorkha earthquake in Nepal in the year 2015 [Kargel *et al*, 2016]; GLOF in Nepal and Bhutan [Higaki and Sato 2012; Gupta *et al*, 2016]. Similarly, it has been observed that earthquakes precede landslides that block rivers that inevitably cause lakes to form and extricates large sections of glaciers or ice walls that fall into the glacial lake and cause GLOF [Wasson and Newell 2015]. Other than these, forest fires are a major cause of land degradation.

Glacial Lake Outburst Floods (GLOFs) erode the bottom**s** of mountain inclines, which leads to adding sediments in the river intern leading to the rising of riverbeds. This rise leads to blockage in the downstream of rivers and the formation of lakes. These lakes can cause outbursts during the rainfall season leading to erosion downstream. The Hindukush Himalaya (HKH) region is susceptible to flash floods, avalanches, earthquakes, landslides and droughts [Shrestha *et al*, 2016]. The HKH recorded 21% of the major disasters since 1980, and 36% of major disasters in Asia were observed by the EM-DAT database [Vaidya *et al*, 2019]. The HKH has observed more than 33 distinguishable GLOFs until the year 2000 [Richardson and Reynolds, 2000]. This provides a background the need to build disaster resilience in Hilly areas and informed decision making at various levels of stakeholders.

The Sendai Framework for Disaster Risk Reduction (SFDRR) was established for a period of 2015-2030 to ensure DRR policy is evolved towards understanding its complexities in the 21st century. The framework aims at multi-sector collaborations to expedite the prevent, prepare for, respond to, and recover mechanism [Aitsi-Selmi *et al*, 2015]. SFDRR indicates the importance of the multi-hazard approach as a more holistic DRR mechanism that integrates bottom-up and top-down decisions, local science and technological expertise, and emphasizes on health, climate change and sustainable development synergies [UNISDR, 2015]. Information, infrastructure, institutions and insurance are four main elements of the DRR framework; they are functional in dealing with complex disasters and mitigating extreme climate events in hilly regions. Because hilly areas are a hotspot for both hydro-meteorological and geophysical hazards, it is essential to understand the extreme weather events and seismic activities in the region to increase resilience. Vulnerability assessment and reduction are effective with real-time data and hazard maps. Through early warning systems, real-time information and risk maps can decrease vulnerability *via* institutional arrangements, capacity-building initiatives for formal and informal organisations will make them successful in sending warnings and providing relief measures.

The mountain communities are highly vulnerable to complex disasters. These rapid and indiscriminate events paralyze human life and nature. Therefore, DRR of these areas coincides with multiple sustainable development goals (SDGs) and agendas. The livelihood and live of the locals are severely impacted due to disasters [Baraua *et al*, 2014]. The examples and understanding of cascading hazards in HKH region (of which Sikkim is a part) clearly indicate that plans and policies are required with people's participation in a bottom up approach. The regions falling under HKH require regional cooperation and local community involvement [Molden *et al*, 2019]. Natural disasters have a cumulative impact in mountainous regions, depending on the frequency and intensity of the past events. This complexity has been observed in North-Eastern Himalayas, which are vulnerable to earthquakes, landslides, mud flow, GLOFs, flash floods and forest fires.

A study was conducted to examine the relevant SDGs, namely 1, 5, 9, 11 and 13 that focus on (a) ending poverty; (b) ensuring gender equality and empowerment of women and girls; (c) constructing resilient infrastructure; (d) making cities and human settlements inclusive, safe, resilient and sustainable, and (e) combating climate change respectively. The study uses Community Risk Registers (CRRs) developed for this purpose. This paper focuses on understanding the challenges and solutions towards community driven DRR in Sikkim, India.

2. MATERIALS AND METHODOLOGY

2.1 Study Area

The topography and geographical location of Sikkim (27°05' to

28°07'N and 87°59' to 88°56'E), makes it vulnerable to earthquakes, landslides, forest fires, GLOFs and biodiversity degradation. The State of Sikkim has a total area of 7,096 km^2 and is stretched over 112 km from North to South and 64 km from East to West [Mishra *et al*, 2020]. It has four major districts north, south, east and west (**Figure 1**). In the North-West, Sikkim has a large number of mountains with an altitude ~9,000 m above MSL including the celebrated third highest peak in the world – Kanchenjunga. Since it lies in seismic zones of IV and V, it is susceptible to the geophysical and hydro-meteorological disasters due to its steep slope terrain. During the monsoon, erratic and heavy rain damages the road network. In recent times, the state has received unusual and erratic rainfall trends with longer and warmer summers. All this has led to a rise in average temperature and shifting winter precipitation from snow to rain, leading to a change in the timing of the peaks of stream-flow that may be attributed to climate change.

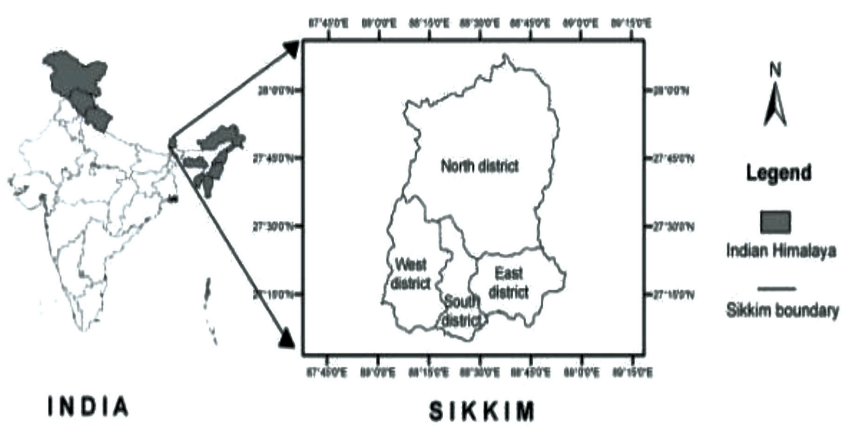

Figure 1: Map of Sikkim showing its location in India and as a part of the eastern Himalayan region (Courtesy: Sandeep Tambe)

2.2 Data Collection and Techniques

The research methodology adopted depends on both primary and secondary sources of data. It was both qualitative and quantitative in nature. Primary data for CRRs was collected by reaching local communities, duty bearers, policy decision makers, researchers, and civil society organisations. The SRRs were prepared especially for teachers, government officials, teachers and school students. A wider community audience was encapsulated by hosting community mela (*Magh* Mela) in the region. The capacity building workshops included safety tips during a disasters and knowledge dissemination through modes of booklets and handbooks. The risk matrix was developed on aspects of separately for each GPUs by identifying and involving different stakeholders further conducting a community matrix with help of a local gram panchayat through focused group discussion. The risk identified were graded (Table 1) based on their impacts (Table 2) and likelihood (Table 3) in the local area. The GPUs selected for conducting CRRs were conducted Chungthang, Mangshila, Lingdong-Barfok and Kabi-Tingda and further four wards were shortlisted for conducting Risk assessment framework.

Table 1: Risk Rating Description

Level	**Description of Risk**
Low Risk	These risks are both unlikely to occur and not significant in their impact. They are managed within existing planning arrangements and require minimal monitoring and control unless a subsequent risk assessment shows a substantial change moving the risk to a higher risk category.
Medium Risk	These risks could cause disruption and/or inconvenience in the short term. The risks should be monitored to ensure that they are being appropriately managed within emergency planning arrangements.
High Risk	These are classed as significant risks. They may have a high or low likelihood of occurrence, and their potential consequences are sufficiently serious to need consideration after those risks classed as 'very high'. Consideration should be given to the development of ways to reduce or eliminate the risk where possible. Multi-agency planning and training should be in place and the risk should be regularly monitored.

Very High Risk	These are classed as significant risks requiring immediate attention. They may have a high or low likelihood of occurrence, but their potential consequences are such that they must be treated as a high priority. This may mean that ways should be developed to reduce or eliminate the risk where possible and also that mitigation (in the form of multi-agency planning and training for these hazards) should be put in place and the risk monitored regularly. Consideration should be given to planning specifically for the risk rather than generic planning. Planning specifically for the risk rather than generic planning.

Table 2: Impact Scoring Scale

Level	Descriptor	Description of Impact
1	Low	Insignificant impact on health, community, transport and infrastructure. Little or no impact on local economy and environment.
2	Medium Low	Small number of injured people requiring first aid treatment. Minor damage to property with a small number of people being displaced for up to 24 hours. Negligible impact on local economy and environment.
3	Medium	Moderate number of fatalities with some casualties requiring hospitalisation. Damage to properties requires additional resources, up to 100 people displaced for 1-3 days. Localised disruption to infrastructure and community services. Short-term impact on economy and environment, resulting in loss of production and clean-up costs.
4	Medium High	Significant number of people affected with multiple fatalities. Significant property damage requiring external assistance. 100–500 peopled is placed for longer than a week. Significant impact on and possible breakdown of some community services. Significant impact on economy with medium-term loss of production. Significant medium to long-term effect on environment.

5	High	A significant number of fatalities and a large number of people requiring hospitalisation. Extensive damage to property. More than 500 people displaced for a prolonged duration and requiring extensive support. Serious damage to infrastructure causing significant disruption and loss of services. Serious impact on local and regional economy. Extensive clean-up and recovery costs. Serious long-term impact on environment.

Table 3: Likelihood Scoring Scale

Level	Descriptor	Description of Likelihood
1	Almost / High	Almost certain Expected to occur in most circumstances
2	Likely / Medium high	Will probably occur in most circumstances
3	Moderate / Medium	Should occur at sometime
4	Unlikely / Medium Low	Could occur at sometime
5	Rare / Low	May occur only in exceptional circumstances

This register was further used to identify planning decisions for community development (Figure 2). The identified risks were presented in a 2D Matrix [Singh and Sharma, 2019] using a qualitative rating. The representation is graphical with a depiction of the seriousness of the risk in the local area. The CRR Matrix sub-themes on extreme weather risk, climate change risk, water risk, forest fire risk, pollution risk, waste management risk, hygiene and sanitation risk, health risk, education risk, house and built-up environment risk, livelihood/economy risk, tourism and heritage risk, transportation risk, power and electricity risk, connectivity risk, governance risk, social risk, chemical hazards risk and other identified risks. Based on the risk matrix developed, developmental priorities were addressed for community resilience.

The Climate School Initiative (CSI) was understood as another important tool for developing resilience awareness for disasters of Sikkim. The initiative focused on interaction between school students, teachers and state departments working together towards understanding the importance of good practices for DRR. The school children and teachers were made aware and explained about DRR methods through the demonstration of weather labs, knowledge of automatic weather station (AWS), painting competitions, lecture series, and workshops. An information guide was created to make children aware of climate change and disaster risks. It aided in the development of SRRs and fused students' larger understanding with DRR.

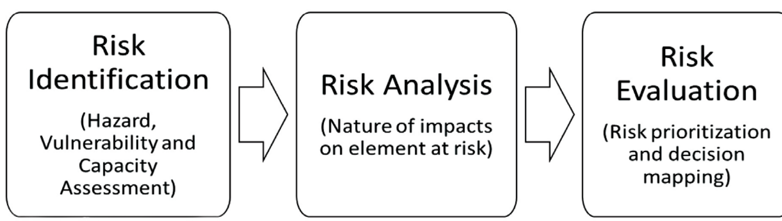

Figure 2: Risk Assessment Process

3. RESULTS

Risk evaluation was undertaken at various levels of governance – from community to the state level. A matrix of parameters was developed on the bottom-up approach, which refines and builds on aspects related to DRR in the study area. Further, various successful aspects and actions during the study, which require strengthening of DRR, were outlined and achieved using CRRs and climate school initiative.

3.1 Capacity Building Initiatives and Risk Identification for DRR

Successful initiatives for GLOFs and weather-related phenomena were related to expedition level studies that completed in probable glacial lakes, like South Lhonak Lake and Rathong Chu Lake. A pilot intervention was initiated at the South Lhonak Lake based on the siphoning technique. An AWS and instrumentation at the location of the sites and multiplication of AWS can strengthen DRR. State-level interventions worked on understanding the need for an adequate number of AWSs, *Manual Weather Stations* (MWSs), Rain Gauges (RGs) and Snow Gauges (SGs) and maintenance and repair of already installed instruments. At the community level, capacity building of the first responders required reinforcement, mass awareness and sensitisation to be established as an essential requirement. Also, hazard specific training needs were to be fortified and funded specially among the younger population. Also, increasing the frequency of stakeholders meetings is an important tool to bring continuity and awareness on risk exposure.

Mediation for forest fires based Focus Group Discussion (FGDs) key actions were established at the district level with an understanding the importance of successful activities, such as intensive patrolling in the forest area during the fire season (firewatcher, camps and fire line maintenance) and the holiday season. Also, the district bodies incorporated suggestions to diminish fire hazard by providing fire-fighting gears to community, constructing water tanks at critical locations, and undertaking extensive community-driven plantation in degraded areas. The following were being considered in future planning: (a) Monitoring using GIS mapping-based data collection of fire occurrences techniques, (b) Planning for training and capacity building to officers and community in firefighting, and (c) Doing rigorous consultations for preparing fire management plan at the State and District level. At the community level, active involvement of Joint Forest Management Committee (JFMC) and Eco-Development Committee (EDC) was sought to manage forest fires and to propagate associated information and mitigation.

The ongoing mitigation measures to address landslides include (a) understanding major geographical landslide locations at Ninth Mile, Namli, rock bolting at Narak-Jhova (South Sikkim), 16th Mile, Jorethang, and Ghorlebhir; (b) Jhora river training works using retaining wall, and (c) anchoring cables at power project Dam site. Further, awareness generation on activities of afforestation at suitable sites, use of geotextile awareness on landslides and strengthened drainage system of all roads were proposed to be prioritized. Uniformity through high-resolution landslide inventory and mitigation works needs to be adopted with adequate technical guidance. Capacity building initiative regarding earthquake safety involved awareness campaign at state level on topics such as retrofitting of buildings, building codes, and site investigation before construction. Also, there is need to develop a handbook and regular checks for quality control construction material and improvement in construction practices. The traditional system of housing is an indigenous knowledge that should be encouraged.

3.2 Suggested Interventions of Resilience Building towards DRR

The GLOFs-based disaster programs could include investments in weather insurance for the community with inclusions of hydro met networking, capacity building of all GPUs of Sikkim with engagements from civil societies, more scientific studies to better understand correlations between complexities. The revival of drying springs and the establishment of water stupas can be explored further in water-based ecotourism initiatives. GLOFs cause high-intensity flash floods, and hence effective communication between State- District-Interdepartmental systems will provide a supportive interface. Hazard mapping, which was piloted in the present study, should be incorporated widely. Effective communication lines will support community established flood primary warning systems.

Management of forest fire based disasters in Sikkim needs to include revision of fire management plans in consultation with state, national and international experts. A designated budget should be provided to the department to manage forest fire events. This will help undertake steps to curb losses, by: (a) regular updating of maps and identifying fire prone areas in scientific manner with expertise from research institutions along with capacity building of state officers and JFMCs; (b) Advanced tactical trainings of forest fire officials; and (c) joint patrolling with JFMC representatives and forest fire army; and (d) real-time monitoring and fire alert system customised for the hilly terrain with coordination from Indian Space Research Organisation (ISRO) and National Remote Sensing Centre (NRSC).

Geological hazards, such as landslides, can be reduced by the introduction of a common utility duct (CUD), monitoring of landslide using EWS, and landslide hazard zonation up to GPU level. A blended research program is urgently required for sustained and integrated landslide investigation and inventory development with the involvement of the state-specific landslide monitoring agencies. The earthquake disaster requires blending capacity building and awareness campaigns to ensure regulated development in the state and motivating communities for complying with land-use guidelines and building codes. Incentive-based mechanism can be developed to encourage households to retrofit their houses, as the cost incurred is normally a major deciding factor. Activities at the district and community level have a vast scope for improvement. Capacity building is required towards building census, seismic code enforcement, risk evaluation of urban and rural areas, identification of evacuation centres, stoking and awareness of unsafe buildings at state level. Community-based disaster preparedness and ensuring regulated development of new constructions will be prudent actions.

4. CONCLUSIONS

During the course of collection and compilation of the data generated, it was observed that community involvement is imperative for DRR and to increase resilience. Such programmes should rest on four pillars, namely: (1) command-control tools; (2) incentives; (3) information dissemination; and (4) technology-based interventions. The command-control tools focus on zonation, regulations, guidelines, codes, and stringency on the choices of the community. Monetary incentives are major driving factors, which can be direct or indirect (such as subsidies, insurance and prize money), for providing early warning. A community can be perused by providing knowledge of the risk they bear and lacunas in the present capacity. This can be perceived by the community positively through active involvement in developing risk maps and its further understanding. Technology-based interventions provide early warning signal and nudge the community towards safety. The CRR matrix outputs develop information on the above-mentioned four strategies, harbouring for effective guidance in development disaster management plans. The ecologically fragile areas of HKH can replicate the CRRs developed in the present study. Also, the CRRs aptly address the key question on DRR framework on gaps towards: (a) enhancement of resilience; (b) beneficiaries of the which require stimulus for following resilience-building processes (individual, community group, state-level), and (d) dependency of a local area on type of disaster event.

Further, it was quantified that combinations of different strategies will be required within the same community or areas for addressing different disasters and their induced effects. The complexities of disaster in hilly areas have been increasing. A consistent framework for measuring the vulnerability and suggesting measures is required for policy makers. The approach of CRRs as a framework for prioritising needs of population even at GPU levels is effective. The study is an attempt to provide direction and guidance for various levels of governance in DRR and management as an obligatory part of development and planning.

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References

1. Aitsi-Selmi,A., Egawa,S., Sasaki,H., Wannous,C., and Murray,V., (2015), "The Sendai framework for disaster risk reduction: Renewing the global commitment to people's resilience, health, and well-being," **International Journal of Disaster Risk Science,** 6(2), 164-176
2. Barua,A., Katyaini,S., Mili,B., and Gooch,P., (2014), "Climate change and poverty: building resilience of rural mountain communities in South Sikkim, Eastern Himalaya, India," **Regional Environmental Change**, *14*(1), 267-280

3. Gupta,V., Nautiyal,H., Kumar,V., Jamir,I., and Tandon,R.S., (2016), "Landslide hazards around Uttarkashi township, Garhwal Himalaya, after the tragic flash flood in June 2013," **Natural Hazards**, 80(3), 1689-1707
4. Higaki,D., and Sato,G., (2012), "Erosion and sedimentation caused by glacial lake outburst floods in the Nepal and Bhutan Himalayas," **Global Environmental Research**, 16(1), 71-76
5. Kargel,J.S., et al., (2016), "Geomorphic and geologic controls of geohazards induced by Nepal's 2015 Gorkha Earthquake," **Science**, 351(6269) *https://doi.org/10.1126/science.aac8353*
6. Mishra,P.K., Rai,A., and Rai,S.C., (2020), "Land use and land cover change detection using geospatial techniques in the Sikkim Himalaya, India," **The Egyptian Journal of Remote Sensing and Space Science**, 23(2), 133-143
7. Molden,D., Sharma,E., Shrestha,A.B., Chettri,N., Pradhan,N.S., and Kotru,R., (2017), "Advancing regional and transboundary cooperation in the conflict-prone Hindukush Himalaya," **Mountain Research and Development**, 37(4), 502-508
8. Richardson,S.D., and Reynolds,J.M., (2000), "An overview of glacial hazards in the Himalayas," **Quaternary International**, 65, 31-47
9. Shrestha,A.B., Bajracharya,S.R., Kargel,J.S., and Khanal,N.R., (2016), "The impact of Nepal's 2015 Gorkha earthquake-induced Geohazards," ICIMOD Research Report 2016/1, Kathmandu, ICIMOD
10. Singh,S., and Sharma,V.K., (2019), *A Handbook on Managing Complex Disasters in the Face of Climate Change*, Indian Institute of Public Administration, New Delhi
11. UNISDR, (2015), Sendai Framework for Disaster Risk Reduction 2015–2030, United Nations International Strategy for Disaster Risk Reduction *http://www.wcdrr.org/uploads/Sendai_Framework_for_ Disaster_Risk_ Reduction_2015-2030.pdf*
12. Vaidya,R.A., Shrestha,M.S., Nasab,N., Gurung,D.R., Kozo,N., Pradhan,N.S., and Wasson,R.J., (2019), "Disaster risk reduction and building resilience in the Hindu Kush Himalaya. In *The Hindukush Himalaya Assessment* (pp. 389-419). Springer, Cham.
13. Wasson,R.J., and Newell,E.B., (2015), "Links between floods and other water issues in the Himalayan and Tibetan Plateau Region," **Pacific Affairs**, 88(3), 653–676
14. World Bank, (2005), "Natural disaster hotspots: A global risk analysis," Disaster Risk Management Series No.5., The World Bank, Washington, DC, USA

D. CROSS-CUTTING THEMES IN DISASTER MANAGEMENT

Manoj Kumar Bindal & Vinita Kumari

Disaster Management: Awareness Generation and Capacity Building

Abstract: Capacity development for Disaster Risk Reduction (DRR) has been identified as one of the main ways of considerably minimizing disaster losses. India being one of the most disaster-prone nations across South Asia, faces threats due to natural disasters owing to its geographical location. Thus, an urgent need arises for Capacity Building through awareness generation and preparedness at all levels is the need of the hour. This paper is an attempt to understand the various underlying threats in and around India. It reviews the definitions of capacity building and its context to Disaster Risk Management (DRM). Further, it reviews the criticality of public awareness and its implementation at the national and state levels. Also, it cites the short-, mid- and long-term training plans of NIDM in building capacity across nation for sustainable development, further contributing to the SDG 2030.

Key words: Disaster Management, Preparedness, Capacity Building, Sustainable Development

1. INTRODUCTION

India being one of the oldest civilizations in the world with a kaleidoscopic variety has a rich cultural heritage. It has achieved all-round socio-economic progress during the last 74 years of its Independence. But, India has been vulnerable, in varying degrees, to numerous natural and man-made disasters owing to its unique geo-climatic and socioeconomic conditions. It is highly vulnerable to various disaster types, namely floods, droughts, cyclones, earthquakes, landslides, avalanches and forest fires.

(a) Risk Profile of India

Out of 36 states and union territories in the country, 27 of them are prone to disaster. Almost 58.6% of the landmass is susceptible to earthquakes of moderate to very high intensity, 12% to floods and river erosion, ~5,700 km of coastline to cyclones and tsunamis, about 68% of the cultivable area to drought, and hilly areas are to landslides and avalanches [NPDM, 2009]. India alongside its surrounding nations has been witnessing a variety of such disasters over the past two decades, which have led to widespread destruction in the form of severe loss of life, infrastructure, loss of economy, livelihoods, destruction to property and the environment.

(b) Policy Planning at International Level

To minimize the loss of lives, damage to properties, and economic and social disruption caused due to natural disasters (specially as witnessed in developing nations), the decade of 1990-2000 was declared as the "International Decade for Natural Disaster Reduction" (IDNDR) by the UN General Assembly in 1989. Also, it cited that by year 2000, all nations must have a comprehensive national risk assessment for natural hazards, mitigation plan, preparedness and community awareness and access to international, national and sub-national warning systems with a widespread dissemination of such warning. But, the need for paradigm shift was felt by disaster experts from the traditional 'active and relief centric' approach to a more holistic approach and hence a shift was introduced from culture of response and relief to culture of prevention, mitigation and preparedness. A conference was held in Yokohama (Japan) in 1994 of the IDNDR in which plan of action was formulated for the afore-mentioned paradigm shift. It was termed as "Yokohama Strategy."

A historical decision was taken by the United Nations in year 2000, when the "International Strategy for Disaster Risk Reduction (ISDRR)" was formulated. The objective was to provide a global framework via the implementation of risk management, hazard mitigation and sustainable development in order to make the communities resilient to the effects of natural disasters.

The "Hyogo Framework for Action 2005-2015" was formulated in 2005 in a conference held in Kobe (Hyogo), Japan, with the aim of: (a) reviewing the Yokohama Strategy and its action plan, (b) rendering best practices and lessons learnt, (c) studying the underlying gaps and challenges, and (d) increasing awareness regarding Disaster Risk Reduction (DRR) policies through all regions and for dissemination of disaster related information to the public.

The "Sendai Framework for Disaster Risk Reduction 2015-2030" set four priorities for action, namely: (1) understanding risk related to disaster; (2) strengthening disaster risk governance to manage disaster risk; (3) investing in DRR for resilience; and (4) enhancing disaster preparedness for effective response and to "build back better" in recovery, rehabilitation and reconstruction. The target is to achieve substantial reduction of disaster risk and loss of lives, damage to properties and economic, social, physical, cultural and environmental assets of persons, businesses, communities and nations worldwide.

(c) Policy Planning and Institutional Framework at National Level

A permanent and institutional set-up for Disaster Management (DM) began as a cell under the Ministry of Agriculture following the "International Decade for Natural Disaster Reduction" (IDNDR) by the UN General Assembly, during the decade of 1990s. A High Powered Committee (HPC) was constituted under the Chairmanship of Shri J. C. Pant, Secretary, Ministry of Agriculture, Government of India, for formulating a systematic, comprehensive and holistic approach towards disasters after a series of disasters took place, *e.g.,* Latur Earthquake (1993), Malpa Landslide (1994) and Odisha Super Cyclone (1999). The HPC report suggested the need of shift in policy from a 'relief-centric approach' to a holistic disaster management approach with a focus on early warning, mitigation and preparedness measures.

The DM division shifted in 2002 from Ministry of Agriculture to Ministry of Home Affairs after Bhuj Earthquake in 2001 (vide Cabinet Secretariat's Notification), and the institutional framework in hierarchical structure for DM evolved in India. The MHA is the 'Nodal Ministry' in the central government for the management of natural disasters at present. Further, multi-level links between different ministries and the DM framework emerged with the objective of addressing disasters and enactment of a suitable law for institutionalizing disaster management in the country. The current establishment is one with multiple stakeholders, involving various ministries, departments and administrative bodies that functions at four levels, namely National, State, District and Local levels.

(d) Disaster Management Act, 2005

The Disaster Management Act, 2005, provides for "the effective management of disasters and for matters connected there with or incidental threat." It lays down institutional, legal, financial and coordinated mechanism for DM at the National, State, District and Local levels through National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA) and District Disaster Management Authority (DDMA). These institutions are not parallel structures and work in close harmony. In particular:

(a) *National Disaster Management Authority*: NDMA is the apex body of DM in the country with the Prime Minister of India as the Chairperson. The objective of NDMA is to build a safer and disaster resilient nation by providing a holistic, pragmatic, multi-disaster and technology driven strategy for disaster management. It is responsible for laying down various policies, plans and guidelines for management of disasters and to ensure timely and effective response to disasters.

(b) *National Executive Committee*: The National Executive Committee (NEC) works as a monitoring and coordinating body for DM under the guidelines of NDMA. It provides necessary technical assistance at State level and to the state authorities for preparation of disaster management plans apart from being responsible for the preparation of the National Disaster Management Plan based on National Policy on Disaster Management and to ensure that it is updated and reviewed annually.

(c) *National Institute of Disaster Management*: The National Institute of Disaster Management (NIDM) was established as per the enforcement of the Section 42 of the DM Act, 2005. The main objective is capacity building besides training, research, documentation and development of national level information base. The Institute works in partnership with varied research institutions within the broad policies and guidelines as laid down by NDMA.

(d) *National Disaster Response Force*: The National Disaster Response Force (NDRF) is formed "for the purpose of specialist response to a threatening disaster situation or disaster." It is a multi-disciplinary, multi skilled force capable to tackle all types of natural and man-made disasters. It works as per the directions exercised by NDMA and is one of the single largest disaster response force in the world. It comprises of 12 battalions located in various parts of the country.

(e) National Advisory Committee: The National Advisory committee (NAC) is constituted under the supervision of Chairman, NDMA. NAC comprises of researchers, experts and scientists having experience of disaster management at national, state or district level. It provides recommendations on various aspects of DM that are research-based along with advising NDMA with regard to formulation of policy at central and state level.

The nation has other national level organizations, such as High-Level Committee (HLC) and National Crisis Management Committee (NCMC), which have various roles and responsibilities to tackle disasters that are natural as well as man-made.

(f) State Disaster Management Authority: The State Disaster Management Authority (SDMA) lays down policies and plan at State level. It provides coordination with regard to implementation of DM plan, provision of funds for preparedness and mitigation of disaster risk, and reviews the developmental plans of various departments at state level.

(g) State Executive Committee: The State Executive Committee (SEC) prepares the State Disaster Management Plan (SDMP) apart from supervising relief and rescue operations during disaster situation and in dissemination of disaster related information to the public. Also, it monitors the implementation of National Policy on Disaster Management 2009 and National as well as State DM Plans, and provides input to the NDMA regarding DM.

(h) District Disaster Management Authority: The District Disaster Management Authority (DDMA) acts as the planning, coordinating and implementing body for Disaster Risk Management (DRM) at district level. The District Collector or District Magistrate or Commissioner is the Chairperson of DDMA. DDMA prepares the DDMP and exercises the guidelines as laid by NDMA and SDMA.

(i) Local Authorities: Panchayati Raj Institutions (PRI), Municipalities, District and Cantonment Boards, Town Planning authorities are part of local authorities that control and manage civil services. Their role is to ensure capacity building of their departmental staff for disaster management, to carry out relief, rehabilitation and reconstruction activities in the disaster affected areas.

But, under special circumstances, where management of disaster situation is not feasible by civil administration, the other forces such as army, central paramilitary forces, state police, fire services and civil defence plan a major role in emergency support functions viz. medical facilities, transportation, communication and search and rescue operations.

The funds that are available at National, State and District level are termed as National Disaster Response Fund, State Disaster Response Fund and District Disaster Response Fund for preparedness and mitigation of disaster risk at national, state and district levels, respectively.

(e) Definitions and Context

As per the DM Act, 2005, "disaster" means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area [DMA, 2005]. Also, the Act refers to DM as a continuous and integrated process of planning, organising, coordinating and implementing measures, which are necessary or expedient for:

(1) Prevention of danger or threat of any disaster;

(2) Mitigation or reduction of risk of any disaster or its severity or consequences;

(3) Capacity-building;

(4) Preparedness to deal with any disaster;

(5) Response to any threatening disaster situation or disaster;

(6) Assessment of the severity or magnitude of effects of any disaster;

(7) Evacuation, rescue and relief; and

(8) Rehabilitation and reconstruction.

UNDP defines Capacity Building as the ability of individuals, institutions and societies to perform functions, solve problems and achieve objectives in a sustainable manner [UNDP, 2007]. And as per DM Act, 2005 [DMA, 2005], "Capacity Building" includes:

(a) Identification of existing resources and resources to be acquired or created;

(b) Acquiring or creating resources identified under sub-clause (i);

(c) Organisation and training of personnel and coordination of such training for effective management of disasters.

And, OECD DAC defines capacity building as the ability of people, organisations and society as a whole to manage their affairs successfully [OECD, 2006].

Public Awareness regarding disaster risk, as per IFRC is the extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken, individually and collectively, to reduce exposure and vulnerability to hazards [IFRC, 2020]. The awareness generation among the public can be inculcated by educating and empowering the people through knowledge sharing and dissemination of information regarding various disaster types, *i.e.,* natural and man-made. Also, the public is made aware about the underlying potential risks so that when a disaster occurs, people in the affected communities respond and act appropriately.

According to UNISDR definitions:

(1) *Disaster Risk Management* (DRM) is the systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities to lessen the adverse impacts of hazards and the possibility of disaster.

(2) *Disaster Risk Reduction* (DRR) is the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

2. NEED FOR AWARENESS GENERATION

At the time of a disaster, generally the human behavior is abnormal and fearful, which further influences the behavior and response of the community. In a disaster situation, the participation of the affected community becomes important, which largely depends on its awareness regarding handling anticipated disasters. The local community in a disaster situation is the first responder. Being the first responders in such disaster situations, it participates significantly during response and DM intervention. Moreover, the community possesses the knowledge and know-how of traditional wisdom along with local coping mechanisms affected owing to the recurrent nature of such emergencies.

The main aim of community awareness programs is to make the community more informed, alert, self-reliant and capable of participating in all activities and programs of DM in close collaboration with government and non-governmental organisations. The awareness will not only promote community participation, but also enable them to understand the following:

(1) Impact of particular disaster, and roles of individual, a family and community to reduce its impact and save life and property;

(2) Government's plan for disaster reduction and available assistance in time of disasters;

(3) Government's limitations of resources and responsibilities;

(4) Need to cooperate with government to overcome the crisis and recover the community as it is in their own interest;

(5) Implementation of self-preparedness measures whenever required; and

(6) Role of community till any external help is available.

3. TYPES OF PUBLIC AWARENESS REQUIRED

At the time of a disaster, the community and government have common goals and are interdependent while tackling the disaster risks. Thus, communities should be provided with all the necessary information, and such flow of information should happen during the non-disaster periods and continue into the disaster periods. The community and local government should work together to handle the emerging issues, if any, during such situations. The community should be aware especially of the following regarding disaster risk:

(1) Designated shelters, which may be a school building or any other safe infrastructure, where people can reach in emergency situation;

(2) Rescue operations and evacuation procedures;

(3) Special warning signals, if any;

(4) Provisions of relief and rehabilitation programs;

(5) Storage and distribution of relief supplies by community;

(6) Actual information given to local authorities regarding actual needs and priorities of the affected people;

(7) Factual information to media agencies and keeping a check on rumours;

(8) Way of helping the most vulnerable section of the community (such as old, differently-abled, women and children); and

(9) Information on likely situation after recurrent disaster.

The key to community participation is community awareness by various awareness generation programs, and undertaking activities. The methods are many to make public aware. Some important methods are listed below:

(1) Use of media and press;

(2) Short films and Folk songs;

(3) Posters, cartoons, charts, photographs and exhibitions;

(4) Organising training camps;

(5) Short-street plays in fairs, religious functions and other celebrations & occasions of public gathering;

(6) Through schools and colleges;

(7) Special lectures by community leaders or well-known persons of the area; and

(8) Group discussions among groups in the community, *e.g.,* Mahila Mandals, Youth Clubs, and Senior Citizens.

Persons who are well aware of the DRR and preparedness programs, will undeniably have more role-clarity and will be well informed and well aware. These persons will become self-reliant in the long run and less dependent on any external agency or local authorities. They will contribute to the best of their abilities during disaster situations. Also, with such persons in it, communities will be able to assess their strengths and weakness and seek help where needed. Village level associations, disaster task forces and youth groups are some of the channels that further help the community in effective community participation.

4. PUBLIC AWARENESS PROGRAMS

There are three approaches for awareness generation in public, namely:

(1) *Face to Face Interaction*: This is most effective method to generate awareness, generally with the help of local governmental bodies, NGOs or Panchayats. In India, rural people are more vulnerable to disaster risk. Although rural people have low literacy rate but can be educated by one on one discussion, street plays, door to door campaigns, panchayat meetings or a group discussion.

(2) *Electronic Media*: The role of electronic media (such as television, radio and social networking platforms) is becoming important for information dissemination. It can help reach the remote corners of the vast land that is India. It possesses two advantages, which are:

  (a) Repeated telecast so as to register maximum coverage in the target area, and

  (b) Comprehension by the public the message conveyed by media as it registers on the masses.

(3) *Print Media and Publicity Materials*: This is an important tool to educate the literate public and the concerned officials. Press highlights the strength and weakness of an awareness generation program as launched by the government and also assesses its efficiency.

5. CAPACITY BUILDING AND CONTEXT

Capacity is the *ability of the people, organisations and society as a whole to manage their affairs successfully* [NIDM, 2013a], whereas Capacity Building is the *creation of an enabling environment with appropriate policy and legal frameworks, institutional development, including community participation (of women, in particular), human resources development and strengthening of managerial systems* [NIDM, 2013b]. Thus, it is a long-term process wherein all stakeholders participate. Capacity building comprises: (a) human resource, organizational and institutional development; (b) training; and legal framework. All individual, communities and organizations have some inherent capacity that should be identified and further developed.

India is highly vulnerable to various natural as well as man-made disasters. It witnesses a large number of disasters, *e.g.,* earthquake, landslide, cyclone, drought, tsunami, *etc*. More than 40 Crore people live under poverty line (with poor livelihood) and many face challenges to have access to basic services, such as housing, electricity, education, and sanitation [WB, 2020] The most vulnerable groups during disaster situations comprise women, children, elderly and differently-abled, besides the poor. Often, during the disaster situation, women are seen as victims and form a vulnerable group. Thus, it is important to engage with women as potential partners for DM activities. Undoubtedly, empowering women is the key to effective DM for enhancement of capacity at community level.

Large scale destruction of properties, infrastructure, services and resources along with economic, social and human loss of human lives, is posing a threat sustainable development and hindering growth and equity. As per various studies, South Asia region (and in particular India) is highly vulnerable to varied disaster types and results in economic losses. This has further pushed the poor people more towards poverty, who bear the brunt of disasters, because they are the most vulnerable group. Therefore, by investing in capacity building at national and sub-national levels, the disaster related risk will be reduced considerably across nation, because disasters have huge economic and social costs and hence investing in capacity building will result in sustainable development and resilient communities. Thus, strategy for capacity building should be such that it is based on understanding with respect to country context and is need-based and demand driven. In fact, the DM Act, 2005, National Policy on Disaster Management (2009) and National Training Policy (2012) have given platform to devise a training and capacity building strategy for DRR at national level.

Although challenges exist in the implementation of such policies at state level, the state level DM Acts and Policies differ in states (such as Assam, Gujarat, Odisha, West Bengal, and Bihar), and this has given a favourable environment for the implementation of capacity building efforts. Coordination between multi-stakeholder partners (such as governmental bodies, NGOs & INGOs, Panchayati Raj institutions, and corporate and private agencies) should help in effective implementation of capacity building strategies at all levels viz. national, state and district. In this regard, multi-stakeholder partnerships have emerged in country, which engage multilateral and bilateral aid agencies (including INGOs & NGOs). The multi-stakeholder coordination and its presence in coordinating DM and DRR activities (including training and capacity development activities) is being implemented in various states and at district level.

5.1 National Institute of Disaster Management

The NIDM is the apex body for capacity building in India at national level. At state level, the DM Cells in the State Administrative Training Institutes undertake capacity building activities. These national and sub-national institutes are engaged in capacity building and training in DM. The NIDM was established in India to effectively implement capacity building activities at national, state and district level. Earlier known as National Centre for Disaster Management (NCDM), the institute is assigned nodal responsibilities for capacity building, training, research, documentation, human resource development and policy advocacy in DM.

NIDM has played an important role in bringing the agenda of DRR to the forefront. It believes in the notion that DRR is feasible through promoting a "Culture of Prevention" involving multi-stakeholders. The Institute works in partnership with different: (a) national, state and district level departments, (b) NGOs/INGOs, (c) academic, research and technical institutes, and (d) various multi-and bi-lateral international bodies. It has prepared long-term training and capacity building strategies for DRR in India. Also, it has undertaken *Post-Disaster Needs Assessment* for various states as well in India.

Section 42(9) of the DM Act, 2005, has assigned the following specific functions to NIDM:

(1) Develop training modules, undertake research and documentation in disaster management and organise training programmes;

(2) Formulate and implement a comprehensive human resource development plan covering all aspects of disaster management;

(3) Provide assistance in national level policy formulation;

(4) Provide required assistance to the training and research institutes for development of training and research programmes for stakeholders including Government functionaries and undertake training of faculty members of the State level training institutes;

(5) Provide assistance to the State Governments and State training institutes in the formulation of State level policies, strategies, disaster management framework and any other assistance as may be required by the State Governments or State training institutes for capacity-building of stakeholders, Government including its functionaries, civil society members, corporate sector and people's elected representatives;

(6) Develop educational materials for disaster management including academic and professional courses;

(7) Promote awareness among stakeholders including college or school teachers and students, technical personnel and others associated with multi-hazard mitigation, preparedness and response measures;

(8) Undertake, organise and facilitate study courses, conferences, lectures, seminars within and outside the country to promote the aforesaid objects;

(9) Undertake and provide for publication of journals, research papers and books and establish and maintain libraries in furtherance of the aforesaid objects;

(10) Do all such other lawful things as are conducive or incidental to the attainment of the above objects; and

(11) Undertake any other function as may be assigned to it by the Central Government.

NIDM aims to build capacity at all levels in the field of disaster prevention and preparedness, and hence provides support for undertaking capacity building to varied national and sub-national agencies engaged in the field of DM and DRM. The library at NIDM provides publication, journals and magazines exclusively on DM and mitigation themes. The methods of imparting training to the participants range over self-learning, face-to-face and on-line modes, and satellite-based training.

Year 2020 and Pandemic: The world at present is facing a pandemic named nCovid-2019. The pandemic initially started with China and shortly spread across the world affecting numerous lives globally. The pandemic has halted the world with its highly contagious property. Countries across the globe are facing varied challenges in education, health, economy, social sectors, and have severely affected the already vulnerable group comprising of women, children, elderly and differently-abled. Besides other sectors, this contagion has harshly affected the education sector wherein Educational Institutions that impart teaching, training and are engaged in capacity building at national and sub-national levels are facing challenges in information dissemination. Keeping this in mind, NIDM, the pioneer capacity building arm in the country, has introduced online webinars, conferences, training and various e-learning programs besides encouraging remote working to minimise the spread of the contagion, showcasing its adaptability and flexibility during the pandemic.

NIDM is consistently engaged in capacity building of policy makers, planners or project designers at the national and state levels, wherein teaching and training is imparted through varied training programs. An exponential rise is observed in the number of such programs post 2019 enhancing the capacity building at national and sub-national levels. For instance, the Institute have trained 5,646 participants in FY 2019-20, which increased exponentially to 45,816 (via webinars) and 16,075 (via training programs) for FY 2020-21 (**Table 1**). Besides participants, there is an increase in training workshops, seminars, conferences, other activities towards building of capacity at all levels.

Table 1: Training Programmes conducted from 2016-17 to 2020-21

Year	**Programs conducted**	**Number of Participants**
2016-17	44	1,429
2017-18	46	1,393

2018-19	52	1,723
2019-20	100	5,646
2020-21 (Webinars)*	193	45,816
2020-21 (Training Programs)*	62	16,075
* Organised till September 2020		

Universities and Institutes play an important role in DRR in the country, through education, dialogue, policy advocacy, debates and research. India comprises of 903 universities and 39,050 colleges. It is observed that out of these only 27 have been actively participating in DRR. NIDM has established the India Universities and Institutions Network for Disaster Risk Reduction (IUINDRR) Network in the country, under which deemed universities will coordinate and come together to share knowledge and resources related to DRM and DRR to the stakeholders working in these domains in the country.

5.2 Key Challenges

Capacity building and public awareness regarding disaster risk ensures DRR at country level. India is a nation highly vulnerable to disaster risks, and it should implement effectively strategies and interventions for enhancing the capacity building at all levels. But, implementation of such activities poses challenges before the policy makers, disaster experts and multi-stakeholders. These challenges include how to:

(1) Ensure training is imparted in a more systematic manner in organized learning rather than an activity that is undertaken in an ad hoc manner;

(2) Achieve a training approach which is need based and demand responsive rather than supply driven;

(3) Identify ways to link training to capacity development agenda and goal;

(4) Identify ways to use training as a means to achieve capacity benchmarks, and not to take it as an end itself;

(5) Ensure that the key stakeholders responsible for capacity

building at national, state and district levels implement the same efficiently;

(6) Assign effectively roles of national and state agencies, local bodies, panchayat, I/NGOs, media and various other agencies during disasters for information dissemination, coordination and monitoring at national, state and district level; and

(7) Ensure public awareness regarding the ongoing pandemic and implementation of standard operating procedures (SOPs) by the various governmental departments, multi-stakeholders and humanitarian agencies.

6. THE WAY FORWARD

India is vulnerable to disasters, because it witnesses a number of earthquakes, landslide, drought, floods, cyclone, tsunami and other disaster types, due to its geographic location. Further, it poses threat to the vulnerable population, e.g., women, children, elderly, differently-abled, poor and marginalized groups. For India, capacity development and public awareness will considerably reduce disaster risk at national, state and district levels. National and local governments, through their DRM platform should coordinate, share information and work toward effective implementation of capacity building plan.

It requires great coordination of Capacity Development activities. In this regard, National governments and where appropriate, local and sub-regional governments, can develop integrated stakeholder-driven Capacity Building strategies that are linked to yet different from any national DRR strategy. These national strategies focus on capacity development efforts and provide various important functions:

(1) Increase awareness of the Sendai framework and the activities associated with capacity building and public awareness,

(2) Increase the participation of relevant stakeholders in the capacity building program,

(3) Combining different capacity building and awareness generation programs and associated activities,

(4) Reduce or eliminate prevalent gaps in capacity building activities,

(5) Provide a platform for information dissemination, coordination and communication,

(6) Establish common capacity development principles, objectives and goals,

(7) Increase national and local ownership and engagement of stakeholder,

(8) Prepare relevant SOPs for various disasters including pandemic and build on contingency plans for capacity building at national level,

(9) Create awareness among people regarding the pandemic situation and ensure people wash hands and maintain social distancing at all times in public places to curb the spread, and

(10) Encourage online dissemination of information and remote working during pandemic for effective implementation of national level guidelines.

Awareness generation of public is important as disasters have now entered our homes in the form of COVID 2019 pandemic. Thus, working on strategies to develop capacity at all levels will ensure that disaster risk is reduced and objective of DRM is achieved.

References

1. NPDM, (2009), National Policy on Disaster Management

   http://www.hpsdma.nic.in

   Accessed on 9 December 2020

2. CPI, (2014), Country Profile of India, East Asia Summit Earthquake Risk Reduction Centre

   https://164.100.60.185/easindia2014/err/pdf/country_profile/India.pdf

   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4534559/

   Accessed on 9 December 2020

3. NPDM, (2009), National Policy on Disaster Management, NDMA, Government of India

   https://www.mha.gov.in/sites/default/files/NPDM-101209_2.pdf

Accessed on 9 December 2020

4. MHA, (2004), Disaster Management in India: a Status Report, August 2004, MHA, Government of India, pp 68–69
5. DMA, (2005), The Disaster Management Act, 2005, No. 53 of 2005
6. MHA, (2005), Disaster Risk Reduction: The Indian Model, National Disaster Management Division, MHA, Government of India, p 3
7. NIDM, (2007), Capacity development for Climate Change Adaptation: MoEF-GEF Climate Change Adaptation Project in India. Tidings, NIDM News, June–August 2007, Vol. II:3

   http://www.ndma.gov.in/en/ndma-guidelines.html

   http://www.unisdr.org/we/inform/terminology

   https://assets.publishing.service.gov.uk/media/57a089b340f0b6497400020a/61044-opm_ifrc_literature_review_v1.pdf

   Accessed on 9 December 2020
8. CADRI, (n.d.) (2016), International Journal of Disaster Risk Reduction: Practical Aspects of Capacity Development in the context of Disaster Risk Reduction

   https://www.sciencedirect.com/science/article/pii/S2212420916300395/pdfft?isDTMRedir=true&download=true

   Accessed on 9 December 2020
9. TST, (2013), TST Issues brief: Climate Change and DRR

   https://sustainabledevelopment.un.org/content/documents/2301TST%20Issue%20Brief_CC&DRR_Final_4_Nov_final%20final.pdf

   Accessed on 9 December 2020
10. DRMP, (2009), GoI-UNDP Disaster Risk Management Program (2002-2009)

    http://sdmassam.nic.in/pdf/publication/undp/gd_practices_in_cbdrm.pdf

    Accessed on 9 December 2020
11. Oxford Policy Management, Jan 2014

    https://assets.publishing.service.gov.uk/media/57a089b340f0b6497400020a/61044-opm_ifrc_literature_review_v1.pdf

    Accessed on 9 December 2020
12. IFRC, (2011), Public Awareness and Public Education for Disaster Risk Reduction: a guide

    https://www.ifrc.org/Global/Publications/disasters/reducing_risks/302200-Public-

awareness-DDR-guide-EN.pdf

https://www.ifrc.org/Global/Publications/disasters/reducing_risks/302200-Public-awareness-DDR-guide-EN.pdf

http://egyankosh.ac.in/bitstream/123456789/40201/1/CDM-01-E-B5.pdf

Accessed on 9 December 2020

13. NIDM, (2020), Annual Training Calendar

    https://nidm.gov.in/tcalendar.asp

    Accessed on 9 December 2020

14. NIDM

    https://nidm.gov.in/pdf/ncrmp/Deliverable%206.pdf

    Accessed on 9 December 2020

15. OECD, (2006), A DAC Reference Document, The Challenge of Capacity Development: Working Towards Good Practice

16. UNISDR

    https://www.unisdr.org/files/58211_fullconciseguide.pdf

    http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000017GE/P001782/M025291/ET/1512453981Institutional_Framework(Anshu.pdf

    https://www.mha.gov.in/sites/default/files/NPDM-101209_2.pdf

    Accessed on 9 December 2020

17. HPC, (2001) Report of the High Powered Committee on Disaster Management *https://www.preventionweb.net/files/1633_ch3.pdf*

    Accessed on 9 December 2020

18. WB, (2020), World Bank Report on Country Overview of India

    http://www.worldbank.org/en/country/india/overview

    Accessed on 9 December 2020

19. UNDP, (2007), UNDP Report, Capacity Development: A UNDP Primer

Alpa R. Sheth

Disaster Management: Preparing Architects and Engineerss

Abstract: Preparing Engineers and Architects to lead the agenda of Safety of Built Habitat has been viewed traditionally as an exercise of imparting necessary technological skills. The focus has thus been on preparation of technical software – training material and resource persons. This has been developed to a high level of sophistication over the past two decades and yet the reality is that most architects and engineers in the country are not proficient in the domain of disaster mitigation. The paper explores reasons for the same and suggests that for better results to be achieved, the issue needs to be framed differently.

Key words: Professionals, Behaviour Change.

1. INTRODUCTION

The role of architects and engineers is crucial at every stage of the Disaster Management cycle that encompasses mitigation, preparedness, response and recovery [NDMA, 2019]. This role assumes centre stage in the disaster mitigation and recovery phases, especially for those natural hazards which are extensive and devastating in their impact. Earthquakes, cyclones, floods have the potential to turn into high risk events on account of vulnerable built habitat. Architects and engineers are at the frontline of growth and development of this built habitat.

The issue of vulnerable habitat is usually framed as a deficit in the technological knowledge -the how - of developing disaster resistant design and construction. This paper attempts to reframe this issue as a more nuanced one. The problem of a safe habitat is not solely about inadequate technological skills- that would perhaps not be so difficult to solve. More significantly, the challenge dwells in the socio-cultural realm of behaviour change which is more difficult to realise.

2. BACKGROUND

The professional community perceives natural disasters as black swan events. A black swan event is defined as one with three attributes [Taleb, 2008]. First, it is an "outlier", as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme 'impact.' Third, in spite of its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable.

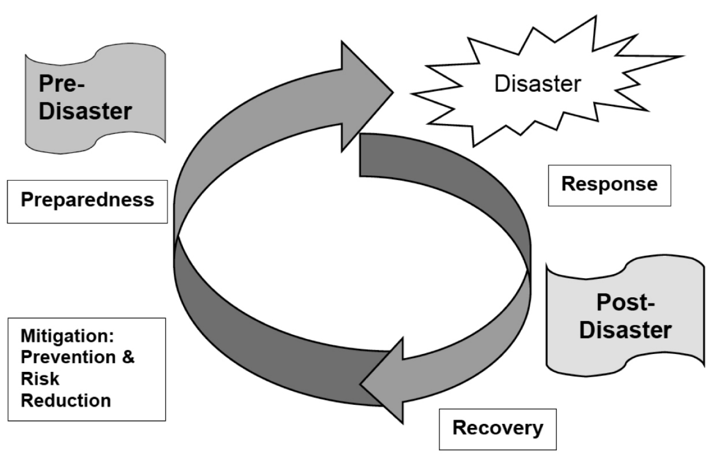

Figure 1: Disaster Management Cycle (Courtesy- National Disaster Management Plan- *www.ndma.gov.in)*

But, *is an earthquake truly an "outlier" event?* The seismic macrozonation of the country as characterized in the Indian earthquake code (IS 1893 Part 1) is a fairly realistic representation of the magnitude and scale of earthquakes that may be experienced in a region even while it makes no prediction of when such an event will happen. With the exception of the Killari earthquake in

Maharashtra in which almost 8,000 people lost their lives, earthquakes in the country have typically been experienced in areas flagged as seismically active and the earthquake intensity has also been within expected limits. Hence, the natural hazard of earthquakes is a "known known" – we *know* what intensity earthquake can happen in a particular place and we *know* that we know this knowledge. This may be contrasted with a known unknown such as we know that a pandemic can grip the world but we do not know its possible scope and scale; Covid 19 has been a good example of a known unknown. Likewise, Cyclones too are known knowns, and we almost always get a few hours (to a few days) warning before it hits an area.

Thus, it is fallacious to dismiss natural disasters as black swan events. The Indian earthquake code has been in existence since 1962 and has undergone many changes over time. The existence of the earthquake code precedes the current generation of practicing architects and engineers. And yet, earthquake risk perception has not been clearly appreciated by a whole generation of architects and structural engineers. This has perhaps been so due to the fact that between 1947 until 2001, no major earthquake has occurred in India with the exception of the 1950 Assam-Tibet earthquake in which about 1,500 people died [USGS, 2020]. As the area affected by the quake was relatively undeveloped and sparsely populated, the Assam-Tibet earthquake did not register in the collective consciousness of the building community in the country. There have been many strong earthquakes ranging in magnitude from 6.0 to 6.9 in the past three decades and the most impactful post-independence strong earthquake event was the 1993 Killari earthquake. The earthquake razed over 52 villages to the ground-the collapsed houses were made of unreinforced random rubble masonry in mud mortar with heavy mud roofs. Urban centres in India did not identify with the building typology of collapsed houses in the Killari earthquake and hence no lessons were learnt by the professional community of engineers. The Killari earthquake was thus a lost opportunity in understand earthquake risk and had little effect on the pursuit of earthquake resistant construction in the country. But, there was a significant impact in the megapolis of Mumbai. The seismic detailing code for concrete (IS 13920) structures was published in the same year as the Killari earthquake and some of the structural engineering community in Mumbai and few other select pockets of the country began implementing this code in high rise buildings. The understanding of earthquake behaviour of buildings was still limited and the new code was followed (along with the principal earthquake code IS 1893) in its prescriptive, recipe-book format.

The 26th January 2001 Bhuj earthquake was the first major earthquake of Independent India (M7.7) affecting an urban centre and was a watershed moment in the history of earthquake engineering in India [NICEE, 2001]. Towns of Bhuj, Rapar, Anjar and Bhachau that were close to the epicenter were destroyed. The Bhuj earthquake played out in real time on a public holiday on national television. The nation's attention was rivetted on the scale of damage and destruction in the bustling city of Ahmedabad, situated 230 km from the epicentre of the earthquake. Many of the damaged and destroyed buildings were constructed less than 15 years prior to the earthquake event. Almost 750 people died as a consequence of over 130 building collapses in Ahmedabad [Jain et al, 2001]. Thousands of buildings were significantly damaged.

In the aftermath of the earthquake, numerous capacity development projects were undertaken. One of the most significant projects was the National Project on Earthquake Engineering Education (NPEEE) [Jain, 2007]. The objective of the project was to build capacity of the civil (structural) engineering and architecture faculty across India which in turn would form the robust resource base (Training the Trainers) for incorporating earthquake engineering into the civil and architecture education in the country. The project was to be an ongoing project without any end date and targeted a minimum of 350 weeks of training each year. NPEEE was wound up after four years with 1,360 teachers trained under the scheme. While the abrupt halt of the project may have been unfortunate, it was not surprising. As a disaster wanes from the public consciousness, the funds for mitigation once perceived as wise investment for a resilient built habitat for the future appear to be an indulgence and an unnecessary utilisation of scarce resources.

Two other programs -National Programme for Capacity building of Architects in Earthquake Risk Management (NPCBAERM) and the National Programme for Capacity Building of Engineers in Earthquake Risk Management (NPCBEERM) also were initiated on the lines of the NPEEE program [MHA, 2005]. The original plan envisaged training of 10,000 engineers and architects each. The project of capacity building of the professional community across the country was initiated with great enthusiasm. Excellent course material and resource persons were mobilised. However, after a few months due to poor response and logistics challenges along with fund constraints, both programs were prematurely halted. NPCBAERM and NPCBEERM faced a daunting challenge of getting the professionals into the classroom. So while the technological software and hardware was available for preparing the professionals for disaster management – Syllabus, Course structure, Course content and material, teaching faculty- the project just did not take off in any significant way and was also halted. ***Why did this project not achieve the success it deserved?***

Architects and engineers are generally aware of their role in ensuring the safety of a built structure. However there is no unambiguous demarcation of liability and accountability amongst the stakeholders. Further, there is no culture of pinning responsibility and so the fear of retribution in the case of any building failure or non-performance of the structure does not inform the performance of the building professional. Building safety is usually considered to be the capability of the building to sustain design 24×7 gravity loads (dead and live loads).Building failures in past earthquakes have not set any precedent for building professionals (structural engineer, architect, supervisor or contractor) to believe that in the event of a building failure they will be punished. *If building professionals do not design for earthquakes (for a multitude of reasons) and if their behaviour is not penalised even in the event of a failure, what is the motivation to change behaviour?*

3. BEHAVIOUR CHANGE

As can be seen from the preceding text, the challenge of preparing engineers and architects for disaster management lies not in technical skill upgradation, but ineffecting behaviour change. When we ask architects and engineers to think about earthquakes and cyclones and other natural hazards, we are essentially demanding a behaviour change. *But why should someone change behaviour?* This is the difficult part. Teaching professional principles of earthquake engineering is relatively easy. Engineer-trainers do not however possess the skills and training to effect behaviour change- which is required to successfully prepare them for disaster management. Almost nothing in the education of an engineer exposes her to humanities. One of the biggest challenges in the education of civil engineering is that there is no course on the subject of "History of civil engineering" currently being offered in engineering colleges. History of engineering involves looking and learning from failures of structures. The subject of History of Civil Engineering straddles both Humanities and STEM (science, technology, engineering and mathematics) and should be offered to every student so that past mistakes are not repeated and one can learn virtually from failures rather than experience it first hand.

3.1 Behaviour Change is a process, not an event

Studies have been conducted on different models of training and some are more effective than others. One of the possible pitfalls of many training programs that are geared towards capacity building is that they are structured to be one-off, discrete events. If one were to draw a leaf from the trans-theoretical model (TTM), one would appreciate that not all people are at the same stage of accessing or accepting new knowledge [Prochaska and DiClemente, 2005].

As per TTM, a person may be in one of five stages of change: *pre-contemplation, contemplation, preparation, action, or maintenance*. These are the stages in the process of behaviour change. They are sequential and cannot be rushed. If I am in the *pre*-contemplation stage, it means I am not even considering learning about disaster mitigation, so there is no point in dragging me to attend the course- the "action" stage. I will resist and even if I am forced to attend I will be mentally absent from the classroom. At pre-contemplation stage, I have no intention to make a change either as I am not sensitised to the need for change or I'm living in self-denial. I need to be convinced or co-opted into the concept that the change will improve something significantly either for me or others, or that if I do not adapt to the change I will be left behind. To move past pre-contemplation, I have to first be sensitised to the "why" of the change. Are there any consequences if I do not change my behaviour? If there are none, I'm going to maintain status quo. Once I understand that the consequences could be serious – such as I could lose my license to practice or I could face punishment for non-performance of a structure designed by me in an earthquake, I may begin to contemplate behaviour change. Having signed on to contemplation, the next steps are easier. I would be ready to prepare for attending training programs or undergo a self study project in the field of disaster preparedness. The action stage also needs to be very carefully structured. should be easily available and at place and time of my convenience. That having been achieved, (and it should be easily possible to create course content that can be distributed over the internet, action (training) and follow-up (maintenance) would be logical next steps. Most of these trainings need to have annual refresher course. These are required not just to brush up knowledge but also to connect with the larger community of professionals and engender a spirit of comradery.

We thus need a change in the outlook and attitude of engineers and architects for preparing them for disaster management. A technological skill upgradation cannot be done in isolation. For example an engineer who does not feel the need to wear helmet while driving his two wheeler will consider designing for earthquakes a nuisance and unnecessary additional work without compensation. Or if the engineer's governing criteria for selection of a home is the location, the layout and the finishes rather than the structural safety of the building, she is unlikely to pay adequate attention to disaster management. She needs a socio-cultural change. She first needs to appreciate the risks she is unconsciously (or otherwise) signing on to. She needs to understand the asymmetry of her choices she is willy-nilly making –High risk and low returns. The risks of death or injury due to an accident when riding a motorbike without a helmet (or in a home not designed for earthquake) are way too high to take for the convenience of not having her head constrained in a helmet (or a home with marble flooring). She needs to be co-opted into the program. And that can only be done by two means- sensitisation and communication of consequences for lack of behaviour change.

Figure 2: Trans-theoretical model: Spiral model of the stages of change
(Courtesy www.health.harvard.edu)

4. CONCLUSIONS

The project of Preparing Engineers and Architects for Disaster management has been undertaken since the 2011 Bhuj earthquake, but a lot more needs to be done to be able to say satisfactorily that significant strides have been made. Programs for achieving this end must be multi-disciplinary. Projects lead solely by engineering academia and professionals have reaped limited results and a lot more is still to be achieved. It is fairly evident that resource persons with subject expertise in fields other than engineering will play a key role in achieving greater capacity building to prepare the building professionals for disaster preparedness.

References

1. Jain,S.K., Murty,C.V.R., Chandak,N.N., Seeber,L., and Jain,N.K, (1994), "The September 29, 1993, M6.4 Killari, Maharashtra, Earthquake in Central India," EERI Special Earthquake Report, *EERI Newsletter*, Vol.28, No.1, January 1994, 8 pages

2. Jain,S.K., Lettis,W.R., Arlekar,J.N., Ballantyne,D., Chaubey,S.K., Dayal,U., Goel,R., Goyal,A., Hengesh,J., Malhotra,P., Murty,C.V.R., Narula,P.L., Saikia,C.K., Singh,M.P., and Vatsa,K., (2001), "Preliminary Observations on the Origin and Effects of the January 26, 2001 Bhuj (Gujarat, India) Earthquake," EERI Special Earthquake Report, *EERI Newsletter*, April 2001, pp 1-16

3. Jain,S.K., (2007), "NPEEE - Looking back," National Information Center for Earthquake Engineering, IIT Kanpur

   https://www.iitk.ac.in/nicee/skj/NPEEE-lookingback.pdf

   Accessed on 12 October 2020

4. Prochaska,J.O., and DiClemente,C.C., (2005), "The transtheoretical approach," American Psychologist (Sept. 1992), Vol.27, No.9, pp 1102–14

5. MHA, (2005), National Program for Capacity Building in Earthquake Risk Management, National Institute of Disaster Management

   www.ndma.gov.in

   Accessed on 12 October 2020

6. NDMA, (2019), National Disaster Management Plan, National Disaster Management Authority,

   www.ndma.gov.in

   Accessed on 12 October 2020

7. NICEE, (2001), "The Republic Day Earthquake in the land of M. K. Gandhi, The Father of the Nation"

   www.nicee.org

   Accessed on 12 October 2020

8. Taleb,N., (2008), "The Black Swan: The Impact of the Highly Improbable," Random House

9. USGS, (2020), M8.6 1950 Assam-Tibet Earthquake

   www.usgs.gov

   Accessed on 12 October 2020

Balaji Singh Chowhan

Disaster Management: Media and its Multidimensional Role

Abstract: Incidence and impact of natural hazards are on the rise, and India due is vulnerable to geophysical and hydro-meteorological events. India has a number of diverse media houses which play an impactful role during various phases of disaster risk reduction. There are several examples of media's effective role and the value of this could be enhanced through collective and coordinated action. Training of stakeholders from media, government and the NGOs has potential to provide dividends. Similarly collective action by media houses will enhance their outreach, effectiveness, increase sustainability, and will provide a viable alternative to local philanthropy.

Key words: Media, Disaster Management, Role, Early Warning

1. INTRODUCTION

The United Nations Office for Disaster Risk Reduction (UNDRR) defines a disaster as a "serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources". On similar lines, the Disaster Management Act, 2005, enacted by Parliament of India defines a disaster as "a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area".

India, with approximately 3.3 million square kilometres of area, and population estimated at 1.3 billion (as per 2011 Census) is considered as one of the most disaster prone and vulnerable countries in the world on account of its geophysical features, hydro -meteorological conditions as well as its socio-economic profile. In India, almost 58.6% of the landmass is prone to earthquakes of moderate to very high intensity; over 40 million hectares (12% of land) is prone to floods and river erosion; of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis; 68% of the cultivable area is vulnerable to drought and hilly areas are at risk from landslides and avalanches [MHA, 2011]. Rapid urbanization, unplanned growth of human settlements, unsafe building practices and multiple layers of socio-economic vulnerabilities have contributed to the rising trends of disaster losses in the country. This has been further compounded by climate change and its impact.

Disaster Management is emerging as a critical function as natural disasters are increasing in frequency and becoming more common in our lives. Natural Disasters 2019, published by Emergency Events Database (EMDAT) mentions that the previous decade (2009-2018) witnessed an average of 343 disasters resulting in 45,212 human causalities and economic losses of US$176 billion annually. In 2019, there were totally 396 disaster events resulting with 11,755 deaths and economic losses to a tune of US$103 billion. Asia was one of the worst impacted and accounted for 40% of the disaster events, and 45% of the deaths. India was severely impacted, contributing approximately 20% to the number of human causalities and 24% to the number of people affected.

Disaster events not only lead to diversion of resources and efforts on a war footing, during the response stage, to manage the immediate impact, but also require resources to rebuild the assets lost during disasters events. In addition to causing damages to natural and built infrastructure, disasters result in erosion of painfully achieved development gains becoming a significant challenge to our socio-economic development process. Natural disasters also lead to environmental damage which further exacerbates disasters. Scientists are discovering that climate change is adding to disaster vulnerability by increasing the lethality and frequency of hydro-meteorological disasters and extreme weather events. Such changes are having a damaging impact on environmental resources. It is observed that many communities depend on natural resources, especially in the middle and low income countries, for their livelihoods. Increasing frequency of natural disasters, climate change impact, and extreme weather events are having a disastrous impact especially on such communities which depend on natural and environmental resources for their livelihoods. Unabated natural disasters could threaten these communities, resulting in mass migration leading to severe socio-economic crises. Recognising the importance of Disaster Risk Reduction (DRR), United Nations has recognised the DRR as a cross cutting or a common theme which will influence achievement of different sustainable goals.

While human and economic resources are critical for Disaster Management, information and information management are equally important for its success. Various disaster events helped us realise that the mainstream, as well as social media, have an important role to play in DM. The High Powered Committee (HPC), set up by Government of India in 1999, mentioned about the need for tapping in to the role of the media for better preparedness, and also having an appropriate media plan to disseminate relevant information to all sections of the population. A 2004 report from the National Disaster Management Division of the Ministry of Home Affairs (MHA) of the government of India (GoI) specifically discussed "the need for a media policy geared to handling the growing phenomenon of real time television reporting, which generates enormous political pressures on a government to respond rapidly and efficiently" [UNISDR, 2007]. In line with these recommendations and discussions, and especially recognising the critical role that media could play in communicating early warning messages during disaster responses, the DM Act, 2005, mentions that "the National Authority, the State Authority, or a District Authority may recommend to the Government to give direction to any authority or person in control of any audio or audio-visual media or such other means of communication as may be available to carry any warning or advisories regarding any threatening disaster situation or disaster". Noting about the important of the role media plays in DM, this article discusses media and its role in DM in the current context.

2. MASS MEDIA – A PERSPECTIVE

By the expression referring to 'mass media', one usually refers to the channels of mass communication such as print media (news papers and magazines), radio, television which provide information to masses. Mass media can be defined as a means to provide information about current affairs, different socio-economic and scientific topics, update ongoing events, entertainment etc. Providing information can have a variety of purposes, such as passing on general information to make people aware about the contextual realities, making people aware or educate or to nudge them towards appropriate or desirable behaviour, providing in depth understanding to people about a specific topic, providing entertainment value, updating on scientific advances, weather forecasts etc. The modern day mass media have their roots in discovery of the modern press, which was brought to India by the Portuguese. The modern press was used by the Christian Missionaries for printing their leaflets. Leaders of the India's freedom movement realised the significance of the modern press for socio-political communication and it went on to play a significant role in the independence movement.

Like in other countries, the mass media in India developed with the evolution of technology and went beyond print into audio, audio-visual, and social platforms. Currently India has a vibrant media industry with more than 5,000 newspapers and periodicals radio broadcasting that began in 1920 has more than 200 radio stations, and with the availability of satellite technology, television, which started experimental transmission in 1959, has currently more than 800 private channels apart from Government beamed

Doordarshan channels. With technological evolution and reforms, satellite technology strengthened instant transfer of information through internet and ushered in the era of social media where the people are able to share the information with world at large directly. This information is not only shared on a real time basis, but direct information sharing among people has also become easier. All these developments have had significant impact on the overall role of the mass media and more importantly in the field of DM.

3. MAINSTREAM MEDIA AND ITS ROLE IN DISASTER MANAGEMENT

Starting from 1935, the Weather Bureau or National Weather Service in the USA started publishing its weather reports in the newspapers. During the 20 century the weather reports also found its place in radios and televisions as the media started using these communication channels.

Currently, media plays multiple roles to support Disaster Management activities. The ability of the media to play a critical role in Disaster Management comes from the fact that they tend to have a wide reach to people and with great speed. Additionally, as a result of an established relationship with the consumers, there is a regular interface at anticipated times, which helps in ensuring that the message reaches the way it is intended, eliciting intended action. These advantages stem from the fact that the media have the ability to collect information from different sources, synthesise it into easy to understand messages and transmit those messages to different Disaster Management stakeholders. Electronic media, especially television channels, can provide information real time, and have a greater coverage on account their ability to communicate with different linguistic communities, children, and to those who are unable to read or write. The audiovisual route of television is also appealing to communities, and the television channels have the ability to repeat the messages round the clock to ensure that they reach the intended audience. Such attributes of television make it suitable for passing on early warning communications or alerts just before disasters strike and help communities at risk to save themselves.

Media have the ability to bring different experts together for discussing ongoing incidents and promoting appropriate solutions which can be used by policy makers, NGOs and the communities to minimise the damages resulting out of the disaster events. By widely bringing the views and opinions of experts into the public domain, media help in providing a direction to relief, rehabilitation activities and to overall policy making. Media also have the ability to promote the feeling of oneness and connect different communities. By doing so, media often play an important role mobilising resources for disaster response and rehabilitation activities. The emerging interface between the mainstream media and social media offers huge potential for the mainstream media to play a more effective role in Disaster Management. Mainstream media one already using this interface to share news and information. There is need to use this interface to a greater degree.

On account of their unique position in the society the mass media can play a significant role in Disaster Management. The role of the media can be appreciated based on various DM phases or analysed functionally. In terms of the phases the role of the media can be divided into: (1) During the Pre-Disaster Phase, (2) During the disaster or disaster response phase, and (3) Post Disaster or during the rehabilitation and recovery phase. Some of the functional examples are presented hereunder from the mass media engagement with DM during the different phases.

3.1 Media as an Awareness Builder

During the pre disaster phase, the media help to bring about a behavioural change that can bring down the risk of vulnerable communities. Media have a strong role to play in building awareness to strengthen disaster mitigation and environmental safeguards. During the ongoing pandemic mass media have been playing a significant role in bringing about behaviour changes related to hand hygiene, wearing masks, social distancing and demonstrating sensitivity to vulnerable and needy communities. Similarly, media have been used in advocating different ways to dispose of agriculture waste, use of public transport, sharing transport etc., recently, when air pollution reached its extreme levels. Also, the media had been promoting different events to popularise practices which could protecting environment by water conservation, using reusable energy from solar sources and building green infrastructure.

Similarly, issues related to climate change are a matter of attention in different media platforms. Many success stories are often shown on the television and written in newspapers and magazines. Media as an awareness builder also play a significant role during the disaster response phase by informing people about their rights and entitlements. Such a role has been played very effectively by the community radio in the recent past because of its ability to focus on local issues. During the recent Covid-19 pandemic, media, especially the television media, played a key role in informing people about the details of the pandemic, different government policies, procedures for accessing services and actions needed to ensure safety.

3.2 Media as an Early Warning Communicator

Sharing of safety related information, between government agencies and communities, before and during disaster events, is a very critical function. Until a few years ago, the inability to generate actionable early warnings was a weakness in India's DM strategies. But, since 1999, India has substantially strengthened its scientific capabilities to develop early warning systems, especially in relation to cyclone and flood forecasting. As a result of these scientific advancements, India now uses advanced computing and satellite capabilities to generate early warning using mathematical modelling as well as satellite observations. The India Meteorological Department (IMD), the Central Water Commission (CWC), the National Centre for Medium Range Forecasting (NCMRF), are all working relentlessly to identify disaster triggers and make early warning generation more precise. After the 2004 Tsunami, India has set up the Indian Tsunami Early Warning System (ITEWS) which is managed by the Indian National Centre for Ocean Information Services (INCOIS) for generating tsunami early warning. India Space Research Organisation (ISRO) with its network of satellites has become very active in generating spatial data useful for generating warnings. Also, ISRO has been collaborating with other scientific agencies to triangulate information gathered from other sources.

In addition to strengthening scientific capabilities, the government and NGOs need to act in tandem, enhance community preparedness for orderly evacuation.

The task of communicating the early warning is an area that is critical to realise the fruits of such capability. With almost 65% of the population residing in the rural areas, many of which are difficult to access in an short time, the penetration of the electronic media, especially television has been very beneficial. Ineffective response is often attributed to the lack of availability of adequate time between the early warning and occurrence of the incident and to community resistance or lack of cooperation. Community resistance for evacuation in light of forecasted disaster events such as cyclones has been a commonly observed challenge in rural locations in India. While apprehensions of some communities, such as concern for their cattle, belongings at home, safety at the relief shelters were realistic, and many apprehensions were a result of socio-religious beliefs and the trust deficit in the early warning systems.

Electronic media played a critical role by repeatedly providing early warnings about impending disasters with suitable real time pictures and the past disasters to refresh the memories of communities. While reporting, the media personnel from the media were present in ground zero or the locations where the landfall is likely to occur which helped communities to understand the gravity of situation. Similarly, even during floods, the media make an effort to keep the community informed about the impending dangers of floods. All such efforts contribute to making early warning communications and follow-up actions effective, which resulted in reducing the death toll in forecasted disaster events, such as cyclones. For instance, during the 1999 Odisha super cyclone almost 10,000 lives were lost, but during the cyclones Hudhud in 2013, Phailin in 2015, Fani in 2019 and Amphan in 2020, the lives lost were orders of magnitude lesser. Media had played an active role in communicating early warning in all the recent cyclones.

3.3 Media as an Information Provider

The power of information can be explained by what happened during the 1999 Odisha Super cyclone. In the context of lack of information from ground zero or affected locations owing to the total cut off in communication, and the availability of just one satellite telephone, information had become a precious commodity. In this context, the amateur ham radio operators successfully connected the Chief Minister's office with the responding agencies which helped plan and streamline response actions. During the various stages of DM, more so during the response phase, information is a critical input for planning and coordination and helps the disaster responders undertake more precise actions. Similarly access to timely information to the people at large helps in escaping from the disaster events, regrouping or find the lost ones, accessing government relief efforts and restarting their lives and restoring normalcy. Realizing the importance of collecting appropriate information, Post Disaster Needs Assessment (PDNA) has evolved into a specialised methodology. Information is also critical for Non-government Organizations (NGOs) who are at the forefront of relief efforts. Hence, many large NGOs keep certain funds in reserve to immediately deploy their teams with an idea not only to provide some immediate relief to affected communities, but, more importantly, to collect information about the damage, needs of the communities and the extent of funds required for providing relief to the affected people. Thankfully, with technological evolution, the media now are able relate stories real time, as they happen.

The media, with their wide access to information from different sources, can be extremely useful in providing a global view as well as specific location/community perspective which is very useful for the decision makers, responders as well as the communities who are affected. A combination of the local mass media in the form of community radio established by the NGOs helps provide needed information about rights and entitlements, safe construction practices and also can bring the voice of the vulnerable communities and women to the policy and decision making processes. One example was the success during the 2002 Kutch earthquake of

Kutch Nav Nirman Abhiyan, a local NGO, with the support of United Nations Development Programme (UNDP). Based on such experiments, GoI has relaxed the rules for setting up community radios. The emergence of social media has added a new dimension to the contribution the media can make to DM. The media often also play the role of countering the rumours or false news helping in avoiding mindless diversion of effort and resources. With the advent of social media tools, information can be obtained directly from information providers in spite of the challenges related to access and remoteness.

3.4 Media as a Provider of Relief

In the recent past mass media companies have started supporting relief operations both directly and indirectly. One of the early and systematic engagement of media organizations with relief came from the India Today group which has its presence in the print, television and digital platforms. In 1999, responding to the Kargil conflict, the India Today group felt that during disaster events the responsibility of media does not stop with reporting but needs to extend to helping the affected communities recover. With this intention, Care Today Fund, an NGO was set up by India Today group, to serve the cause of soldiers affected during the Kargil, started responding to the 1999 Odisha super cyclone. Starting with this, Care Today Fund with the support of India Today Group consistently responded to different large scale like the Gujarat earthquake (2002), the Indian Ocean Tsunami (2004), the Kashmir Earthquake (2005) and others. The deep routed philosophy which guided those actions was that the job of media does not end with reporting. For the many years in the past other major media houses such as Indian Express, The Hindu, NDTV and others have also supported the relief efforts either by endorsing well meaning NGOs, donations to Prime Minister's Relief Fund or by collecting the donations and routing to the PM's relief Fund. NDTV also holds annual day-long event to raise donations for different useful environmental projects. A group of British media houses operate a bit separately. Some of the leading media houses from UK have established a consortium called Disaster Emergency Committee (DEC), in partnership with top 12 charities of UK makes a combined appeal to the people and the amount collected from the appeal is used by the identified charities in a fixed proportion during the relief phase. Projects are developed for the remaining unspent donations.

3.5 Media as a Policy and Opinion Influencer

This is one of the primary functions of the mass media for different domains and thoughts. The media houses also play such a role in DM. By holding discussions around issues of disaster response, the media companies, both the print and electronic, have been contributing to influencing government strategies around DM. Many such discussions have pointed to challenges pertaining to coordination among the government agencies during different phases of DM and the need to strengthen the same. There is a great opportunity for the media to join hands with the Civil Society to influence the policy environment.

3.6 Media acting against False Information

False information and rumour mongering are common during disasters and communities in need of relief often fall prey to them. In a recent statement, MHA mentioned that, during the Covid-19 pandemic false information contributed significantly to labour migration from the cities. The media, in such a situation, can play a constructive role in clarifying information and helping communities learn about the truth. Many media houses did play such a role by identifying false news / information during the pandemic and informing the truth.

4. SOCIAL MEDIA

Advances in satellite based communication technology have resulted in the growth of social media as a means of interactive communication. Using social media platforms, group of users can interact with other individuals. Advent of social media has ensured that victims of a disaster are able to communicate directly with their families, friends, authorities, relief providers, and opinion makers to inform about their safety, current situation, immediate needs or the plight of those around them. Similarly, individuals with voices are able to communicate to others about the need for action. The social media have also become a very useful tool for exchanging information among stakeholders with common interests or roles. It is common for humanitarian actors, government officials to come together on the social media platforms to quickly disseminate information about among the members. Social media platforms are also being used by the telecommunication companies to push warning to its users. During the ongoing pandemic response information had been shared and transmitted using several social media platforms.

During the Kerala floods in 2015, social media were successfully able to support people to people communication, volunteering and extending support to the vulnerable especially the aged population whose children were staying in some other parts of India or in other countries. Post disaster, during the rehabilitation phase, the media plays a role of advocate of appropriate practices to rehabilitate the affected communities and to mitigate losses on account of similar disaster events in the future. When a group of Civil Servants from the Government of India came together to establish Civil Services Association Reach to Support National Disasters (CARUNA), their internal communication was supported by social media and technology platforms. Also, Social media plays a significant role in crowd sourcing donations and resources, and as a connect between the donors and communities or local organisations helping in resources reach the needy directly.

The advent of the social media and the ability of a citizen to report directly have introduced a different dimension to the information flow. With social media there is no more a need for the information to be collected by professional journalists from the media houses. Communication can be put together directly by the people on the ground and communicate using different social media tools available currently. Thanks to the access to the technology and the social media tools such communication could reach many audience and countries with a lightning speed. Some special features such as marking oneself safe on the Facebook accounts were very popular during the recent floods in Kerala. The advent of the social media has also brought in the challenges of circulation of false and unverified news which could mislead the masses and the exclusion of those who do not have the capability to use such social media tools. But, the benefits offered by the social media make out a strong case for managing it in such a way that the benefits should be preserved and offered to the citizens of this country.

5. RECOMMENDATIONS FOR REALISING THE FALSE POTENTIAL OF THE MEDIA IN DM

The ability to make a significant difference to the lives of common people places a significant responsibility on all actors engaged in DM. This is especially true of the media, and hence, one needs to be cautious not to err and contribute unintended faux-pax. In the following, some recommendations are made on the media's role more collective in DM.

5.1 Develop and Adopt Guidelines on Disaster Reporting

Often there are complaints about the manner in which media handle reporting during disasters. Coverage of floods in the state of Jammu and Kashmir in 2015, and the Nepal earthquake response in 2015 are some examples. Recently the Supreme Court remarked that, "the power of electronic media is huge. It can become a focal point by targeting particular community or groups". During disaster response certain discussions may lead to unintended socially complex situations detrimental to the process of disaster response. In order to avoid any unintended damages, the media entities could develop certain guidelines related to disaster reporting. Sensitivity about local cultures and social practices, avoiding stereotyping and bias, violation of personal space of the victims are some of the suggested areas for which guidelines could be developed. Civil Society stakeholders can be very useful partners to media entities in this endeavour.

5.2 Maintain Sustained Focus beyond the Initial Response Phase

It is often pointed out that there is a tendency in the mass media to shift focus from disaster events when some other strong story develops in other parts of the country, often termed the TRP centred approach. This is understandable as they need to survive in a competitive business environment. It is also observed that the focus of the media dilutes as the initial panic situation is over which results in very weak reporting about the issues pertaining to rehabilitation and recovery of the affected communities. The media will be able to help the affected communities by helping providing information that helps in disaster preparedness, maintaining a sustained focus on disaster impacts, regularly visiting the affected locations and communities and reporting about the status of the rehabilitation and recovery efforts for the affected communities.

5.3 Collaboration among Media Entities and with other like-minded Stakeholders

There is a strong case for the media companies to collaborate among themselves and converge their strengths with other stakeholders. In one such example, several British media companies converged and collaborated with popular UK Charity Organisations and formed a DEC. The media entities involved in DEC make a common appeal and the funds generated agreed to in advance appeal are used by the charities involved in DEC in agreed manner. Such a mechanism helps in motivating individual donors to donate by avoiding confusion about which charity to donate. This will mean that the media companies should be able overcome their competitive spirit towards each other for the purpose of achieving greater social good. Such a self-actualisation seems to be far away in Indian context and will need time and strong leadership within media industry.

5.4 Enhanced Interface between Mass Media – Social Media

The smart phone has become a platform which performs functions beyond the personal communication. There is already a growing use of social media tools by the media entities for their routine business operations. Media entities should also explore the use of social media tools for achieving the objectives of DM. This can be done by sharing stories related to disasters on various social media platforms which are working in the DM space, setting up dedicated social media platforms which can bring different disaster response stakeholders together.

5.5 Promotion of Training of Government and Media Functionaries

Several disaster events have proved the criticality of the media's role beyond doubt. In order to realise the benefit of that role in DM, the government needs to clearly communicate its expectations from media entities during disaster events. The government in partnership with NGOs and other training institutions such as the National Institute of Disaster Management (NIDM), and the State Administrative Training Institutes (ATIs), should organise training for media personnel to discuss about issues related to vulnerability, principles of disaster event coverage, the sensitivities which needs to be demonstrated towards the affected communities and responders. Also, there is a special need to train local level functionaries regarding working with the media to make DM more effective.

Disclaimer

Opinions expressed by the author in the paper are personal.

References

1. Dwivedi,R., (2010), "Role of Media in the Disaster Management and Early Warning," bepress.com; https://works.bepress.com/ratnesh_dwivedi/27/
2. Fraustino,J.D., Liu,B., and Jin,Y., (2012), "Social Media use during disasters– a review of the knowledge base and gaps," START; https://start.umd.edu/sites/default/files/files/publications/START_SocialMediaUseduringDisasters_LitReview.pdf
3. Kind,D., and Cottrell,A., (_2006), "Does the Media Prepare People for a disaster," https://www.jcu.edu.au/__data/assets/pdf_file/0009/123489/jcutst_056208.pdf
4. MHA, (2011), Disaster Management in India, Ministry of Home Affairs, Government of India: https://www.unisdr.org/2005/mdgs-drr/nationalreports/India-report.pdf
   Accessed on 12 October 2020
5. Ray,G.N., (2009), "The Changing Face of Indian Media,"
   National Press Day on November 16, 2009 organised by the Press Council of India in collaboration with Government of Andhra Pradesh and AP Press

http://presscouncil.nic.in/OldWebsite/speechpdf/November%2016%20 2009%20Hyderabad.pdf
Accessed on 12 October 2020

6. Reilley,P., and Atanasova,D., (2016), A report on the role of the media in the information flows that emerge during crisis situations, http://casceff.eu/media2/2017/02/D3.4-Media-in-the-information-flows-during-crisis-situation.pdf
7. UNISDR, (2007), National Report
https://www.unisdr.org/2005/mdgs-drr/national-reports/India-report.pdf
Accessed on 12 October 2020

B. Vyasa Krishna

Disaster Management: Financing and Insurance

Abstract: The disasters are major risks for any country resulting into huge financial losses together with fatalities and damage to the public properties. The allocated funds hardly meet to manage relief measures. The disaster-prone countries like India, need well-defined risk transfer and risk management mechanisms. In this regard, various agencies of United Nations within its system including the World Bank and Asian Development Bank are providing lot of information on risk sharing and risk managing models. They made initiatives to provide technical assistance and financial support for countries seeking customized solutions to meet their unique requirements. The approach includes designing of regional sovereign catastrophe risk pooling and other risk facilities. These mechanisms involve setting up of exclusive insurance entities and tapping the capital markets with insurance linked securities, *etc*. Such initiatives are in its infancy in India and there is an immediate need to look at such innovative measures and develop a model suitable to manage disaster risks in the country.

Key words: Disaster, risk transfer, risk pooling, financing, management.

1. INTRODUCTION

The disaster risks intersect with a wide range of environmental, social, and governance risks causing human, economic, and financial losses and social impacts. The occurrence of a disaster event batters the poor and the vulnerable sections the most, because of their lack of resources to strengthen to ward off or to make settlements at a safer place, not prone to disasters or perils. The relief from the government and to an extent from humanitarian agencies will not suffice to the extent of damages caused. Apart from fatalities and productive assets, the losses to the public properties would also massively force the governments to restore the infrastructure facilities at the earliest possible time and provide rehabilitation measures to the affected populace. The developing countries are vulnerable to meet these challenges and need a lot of time to recover from such an impact.

The disaster risks are better understood by the insurance industry to manage and also carry them to provide financial relief. The UN Conference on Sustainable Development launched the *Principles for Sustainable Insurance* in June 2012 at Rio de Janeiro (Brazil) as a framework for the global insurance industry to address environmental, social, and governance risks and opportunities as developed by the *UN Environment Programme's Finance Initiative*. The *United Nations Office for Disaster Risk Reduction* (UNDRR and formerly UNISDR) is the United Nations focal point for disaster risk reduction. It aims to systematically avoid, lessen or transfer the adverse impacts of hazards and the possibility of disaster and brings governments, partners and communities together to reduce disaster risk and losses to ensure a safer, more sustainable future [UNDRR, 2015].

There are a range of activities and elements before and after a disaster event, namely:

(1) **Understanding and assessing disaster risk** – Effectively managing disaster risk must start with an understanding of its causal factors. Hazards, exposure and vulnerability are determinants of disaster risk.

(2) **Disaster risk reduction and prevention** – Mitigating the causal factors of disasters through reduced exposure to hazards, lessened vulnerability of people and property, and increasing resilience.

It also involves building the capacity of a community, and its emergency services, to prepare for, and cope with an event.

(3) **Disaster response and relief** – Responding in the aftermath of an event to save lives, treat the injured, protect property and meet basic human needs.

(4) **Disaster recovery** – Restoring facilities, livelihoods and living conditions of disaster-affected communities.

(5) **Disaster risk financing –** The shifting of the economic burden of loss to another, through risk-sharing or risk transfer mechanisms, such as insurance.

2. DISASTER MANAGEMENT IN INDIA

The frequent occurrences of disasters which bring huge financial losses many times together with fatalities received the attention of national governments. The United Nations with its specialized agencies on its part has initiated many activities to support the countries in managing disasters through innovative financing mechanisms and provision of insurance covers.

After the adoption of the Disaster Management Act, 2005, setting up of National Disaster Management Authority (NDMA) at the Centre and State Disaster Management Authorities (SDMAs) in the states, the administrative ground has been developed enough for the management of the events. The initial emphasis of the NDMA has been provision of infrastructure in all disaster-prone areas, setting up National Disaster Response Force and organizing training and sensitization on disaster management in a big way. The NDMA with its state supporting units have developed advanced systems in alerting the areas of possible disasters in advance and take measures to prevent fatalities in the event of a disaster, which can be termed as a major achievement made in disaster management (DM) in India so far.

3. DISASTER RISK FINANCING IN INDIA

The financial assistance to meet the rescue and relief expenditure during any (notified) disaster event is governed by notified guidelines on the State Disaster Response Fund (SDRF) and National Disaster Response Fund (NDRF). These funds have been created under the legal framework of 48(1) (a) and Section 46 of the DM Act, 2005 respectively. The State Governments are primarily responsible for the execution of relief operations in the wake of natural calamities. The Government of India supplements the efforts of the State Governments by extending additional financial assistance from NDRF. The funds from SDRF and NDRF are released to assist States to provide immediate relief. The assistance for long-term reconstruction of assets is provided through overall development plans of the Centre and the States and is not covered under the norms and guidelines of the SDRF and NDRF.

The assistance provided by NDRF is on 100% central grant basis, whereas, in the case of SDRF, states also need to contribute their share as per successive Finance Commission's recommendations. The NDRF is maintained by the Government of India in the Public Account. A limited size cess (NCCD-National Calamity Contingency Duty) backed the fund earlier. After the implementation of GST, most of the cess(es) are subsumed in GST. Hence, the size of cess is narrowed down and not sufficient to fulfil the growing needs of disaster funding under NDRF. Therefore, now as per requirement, necessary budgetary support is being provided for NDRF.

The 13th Finance Commission (13FC) had recommended differential State shares, with general category States contributing 25% and special category States contributing 10 percent, and the balance being contributed by the Union Government as grants-in-aid. The 14th Finance Commission (14FC) has recommended an amount of Rs.61,219 Crores as the aggregated corpus of State Disaster Response Fund (SDRF) for all States for the award period 2015-20 with state contribution of 10% (Rs.6,122 Crores) to SDRF, the remaining 90% (Rs.55,097 Crores) coming from Central Government. The Government has accepted the above recommendations of FFC with a modification that the percentage share of the States will continue to be as before (i.e., during 13FC award period) and it was agreed that once GST is in place, the recommendation of 14FC on disaster relief would be fully implemented. Thereafter, from the year 2018-19, the share of states in SDRF has been decided at 10% and the rest 90% is being contributed by the Centre [Meena, 2020].

The foregoing discussion shows that the allocation of funds is meant for rescue and relief operations. But, it is observed that the allocated funds hardly meet the requirements of basic relief measures. In the event of a disaster, apart from the losses of assets of all sections of society, the losses to the public properties due to disasters are also huge. The damage and loss is massive to the infrastructure facilities, like roads, railways, power lines and communication systems.

Of late, India has got assistance from World Bank towards the cost of the National Cyclone Risk Mitigation Project (NCRMP) Phase II in the year 2019 and the project intends "to develop disaster risk financing strategies which will help the authorities dealing with disaster at national and state level to address resources gap in aftermath of a natural disaster". It is worth mentioning the observation made by NDMA that, "despite the recognition of adverse fiscal, economic and social consequences of natural disasters, there is no formal ex-ante disaster risk financing mechanism in place and instead an over-reliance on post-disaster funding". The above-referenced document has admitted that "while there's more focus on the need of financing all stages of Disaster Risk Management (DRM) (and not just response), concrete mechanisms and instruments for doing this are yet to emerge. Disaster Risk Financing (DRF) that addresses the underlying drivers of contingent liabilities emerges as a big gap in India". However, "the NDMA seeks to develop a Comprehensive Multi-hazard Risk Financing Strategy (CMhRFS)" [NDMA, 2019]. Though NDMA has started working towards the development of a disaster risk transfer and financing strategy for the country, there are no well-defined risk transfer mechanisms in place to manage disaster losses in India. This is considered as a major 'gap' in disaster risk financing in the country.

The Insurance Industry in India is regulated by the *Insurance*

Regulatory and Development Authority of India (IRDAI). One of its mission statements is 'to bring about speedy and orderly growth' of the insurance industry. India has well-developed public and private sector insurance companies to jointly provide the required technical knowledge and financial resources to design and implement suitable disaster risk transfer mechanisms through insurance. There are well-developed insurance covers available for private properties in India. The Fire Insurance cover always has an option for insuring these perils. Some policies have these perils included automatically while it's an optional coverage in some policies. As the insurance penetration is low, the insurance coverage for property in the country is minimal.

In the case of agriculture insurance, which is highly vulnerable to climatic changes and disasters, the Government of India has developed crop insurance schemes, the latest being Pradhan Mantri Fasal Bima Yojana (PMFBY), being administered by insurance underwriters from public and private sectors and the policy covers the Act of God perils as well. The insurance cover (including PMFBY) so designed and has been made mandatory for all crop loan accounts of formal lending institutions with a provision of government premium subsidy to protect the interests of farmers with better uptake. As the subsidy is available only to the government scheme/s, there's no initiative by the private sector to design better insurance covers in this area. But, the major issue in all these schemes is that they are largely oriented towards mitigating the credit risks of the lending institutions rather than orienting towards mitigating the risks of crops and that of farmers. Noting various challenges in the PMFBY scheme, the Government of India has made the scheme optional now.

The following measures were suggested for better disaster risk transfer mechanisms through insurance:

(1) Increasing awareness amongst the masses about insuring their assets against possible losses on account of natural disasters;

(2) Mandatory insurance of public infrastructure, critical infrastructure and public utilities like airports, railways, ports, etc;

(3) Development of affordable standalone catastrophe insurance products including parametric insurance solutions covering risks like earthquakes and cyclones;

(4) State-sponsored or subsidized insurance cover for the life and property of the masses belonging to the BPL (Below Poverty Line) segment;

(5) Mass insurance schemes for protection of agriculture sector against the onslaught of disasters; and

(6) Focussed research and studies on various aspects of Risk transfer Mechanism in Disaster Management [Mathur, 2016].

It is noted that "the government, the insurance regulator and various other stakeholders are in the process of developing a suitable risk transfer mechanism so as to mitigate the risks arising out of disasters. The various measures have been identified which can facilitate greater penetration and thereby build a robust risk transfer mechanism".

After the break-out and spread of the Corona Virus Disease-2019(COVID 19) globally in early 2020, IRDAI constituted a Working Group (WG) on 8th July, 2020 'to explore the possibility of addressing these risks and any other risks arising out of a Pandemic through the mechanism of a Pandemic Risk Pool'. In its Report submitted to IRDAI on 1st September 2020, the WG recognised 'the need for systematically designed well-structured pandemic pool' to 'address losses and unsettlement caused to the informal and low-income sectors of the society and serve as a medium of providing relief to these sectors by the Government in case of any such pandemic or epidemic events in future.' The WG recommended thus, "a public-private pandemic pool with participation from insurers and government support as a backdrop can be a best suitable option to prepare us better from similar future events" [IRDAI, 2020].

These developments show that IRDAI has effectively taken steps to address the pandemic risks through insurance.

4. DISASTER RISK FINANCING MECHANISMS

The regular occurrence of natural disasters and at times pandemics, like COVID 19, put a significant fiscal burden on governments and can create major budget volatility. With rapid changes in climatic conditions, the fiscal burden of natural disasters on developing countries is expected to continue to rise. These issues force countries to look for innovative solutions for risk mitigation and disaster risk transfer mechanisms. These efforts led to setting up various forms of public-private support systems to manage disaster risks involving varying levels of intervention. The countries have their own way of addressing the issue employing varying mechanisms involving interested agencies for partnership for this endeavour. The instruments of finance adopted are different basing on their local needs and available resources. A broad landscape of DRF mechanisms is depicted in **Table 1**.

Table 1: The Current Landscape of DRF Mechanisms [Montier et al, 2019]

Red Cross Red Crescent	NGOs	UN	Government
Forecast-based financing pilots	Start Anticipatory Fund	FAO Early Action Fund	National DRF Systems
Forecast based action by the DREF	In development: Start Financing Facility	WFP Immediate Response Mechanism	MDB contingent financing instruments, e.g., World Bank CAT DDO Action
In development: New products including cat bond	Start ARC Replica and other risk financing pilots	In development: CERF Early Action Approach	Pandemic Emergency Facility Famine Early Action Mechanism Sovereign Regional Risk Insurance Pools

In this regard, the United Nations and its specialized agencies have been supporting the countries that are evincing interest to develop local or regional solutions to manage these risks through various risk financing models. The Disaster Risk Financing and Insurance (DRFI) Program has been set up in 2010 to help countries ensure that their populations are protected financially in the event of a disaster and to improve the financial resilience of governments, businesses, and households against natural disasters. This is a joint initiative of the World Bank Group's Finance, Competitiveness, and Innovation Global Practice and the Global Facility for Disaster Reduction and Recovery (GFDRR). The initiative aimed to support governments to implement comprehensive financial protection strategies and brings together sovereign disaster risk financing, agricultural insurance, property catastrophe risk insurance, and scalable social protection programs. At times, it may help governments work with the private sector to facilitate public-private partnerships [WB, 2020].

The Organisation for Economic Cooperation Development (OECD) organized a survey of 29 countries in the year 2015 on the practices and challenges and found that a wide range of approaches to the financial management of disaster risks have been implemented across economies, reflecting differing levels of disaster risk and economic development. However, a number of common challenges were identified across economies which suggests the need for further investment in developing comprehensive approaches to disaster risk financing. The survey noted that the risk transfer tools to manage impacts of disasters have been employed in a few countries only while comprehensive coverage of disaster risks remains a challenge in many economies. The survey identified a need to enhance technical and institutional capacities and co-ordination among domestic stakeholders involved in the management of disaster risks [OECD, 2015].

While financing the risks, there are various risk transfer mechanisms that are employed by countries and agencies availing possible options.

5. DISASTER RISK TRANSFER MECHANISMS

The Risk transfer is a mechanism to transfer risks from one party to another for a consideration. While insurance is a traditional way of transferring risks, alternative risk transfer mechanisms are needed to handle risks of catastrophic in nature. The Alternative Risk Transfer (ART) is a risk protection that is done outside of the traditional models of an insurance programme. The ART blends risk retention and risk transfer at the lowest total cost of risk and results in mutually aligning the financial interests of both the insurer and the insured. There are two broad segments to the ART market. These two segments are risk transfer through alternative carriers and risk transfer through alternative products. For the most part, the alternative carrier concept encompasses self-insurance, pools, captives and risk retention groups (RRGs). The Risk transfer through alternative products generally includes transactions such as integrated multiline products, insurance-linked securities (or CAT bonds as they are commonly referred to), credit securitization, committed capital, weather derivatives, and finite risk products [Giddy, 2020].

Table 2 gives some of the risk transfer and management tools that are available with their advantages and challenges duly enumerated:

Table 2: Disaster Risk Management Tools [UNU, 2017]

Name of the Tool	**Category**	**Description**	**Application examples**	**Advantages**	**Challenges**
Indemnity insurance: (a) Single Peril (b) Multiple Per	Traditional insurance	Insurance in which the claim is calculated by measuring the degree of damage to the insured asset soon after the event occurs	Many examples in the developed countries, including hail insurance, flood insurance and multi-peril agricultural insurance.	Indemnity based on actual damage. Established distribution pathways. Proven scalability	High transaction costs, including moral hazard and adverse selection. High barriers to entry in some cases, so excludes vulnerable population groups.
			Limited examples in developing countries, mainly from big government schemes in Latin America (e.g., Pro-Agro Brazil and Mexico).		

Name of the Tool	Category	Description	Application examples	Advantages	Challenges
(a) Area-yield (b) Weather-indexed (c) NDVI/ satellite-based	Index insurance	Pay-out is calculated according to what is usually an independently verified proxy (index), rather than the actual damage to the specific asset.	Limited examples in both developed and developing world. But pilots are increasingly common in developing countries, with the following schemes operating at scale: (a) Indian National Agriculture Insurance Scheme. (b) Ghana Agricultural Insurance Pool. (c) Kenya and Ethiopia Index-Based Livestock Insurance.	Lower transaction costs than indemnity insurance. Less demanding of institutional capacity, monitoring capacity and financial literacy than indemnity insurance.	Weak farmer demand and first-mover problems. Basis risk. Insufficient public investment in necessary infrastructure (i.e., weather stations, etc.). Not a 'profitable' form of risk transfer so would have to be substantially reliant on government or donor funding.
Natural Catastrop-he Bonds	Alternative risk transfer tools/ insurance-linked securities (ILS)	Securities that transfer natural catastrophe (re) insurance risks to the capital market	Many examples in developed regions. World Bank's Multi-CAT programme facilitated CAT bonds for sponsors including the Government of Mexico. Additionally, Munich Re recently expanded its third-party capital ILS investor base for catastrophe bond issues.	For investors: relatively high returns and low correlation with other asset classes means the promise of diversifica-tion. For sponsors: CAT bonds allow access to a much bigger pool of capital, and longer coverage periods, than conventional re-insurance.	Significant barriers to entry for developing country governments, e.g., lack of familiarity with reinsurance and CAT bonds; lack of resources to deal with complex legal

Name of the Tool	Category	Description	Application examples	Advantages	Challenges
					documentation and high transaction costs; limited or non-existing modelling of disaster exposure; other political disincentives linked to insurance (see elsewhere in the paper).
Sidecars	Alternative risk transfer tools (ILS)	Securities that transfer a quota-share portion of the risk to the outside investors in the capital market. Generally, have a limited lifespan and are used to capture the increase in rates after a major catastrophe.	Many examples of this in (re) insurance companies. Munich recently expanded its third-party capital ILS investor base for collateralised sidecar issues (Eden Re II sidecar)	For investors: relatively high returns and low correlation with other asset classes means promise of diversification, while the quota set-up limits the extent of the risk. For insurers: sidecars allow access to a much bigger pool of capital, the limited lifespan offers quick access to capital and the quota-system allows for splitting up of larger risks.	Significant barriers to entry for developing country governments (see above). No focus on vulnerable populations.
Weather Derivatives	Alternative risk transfer tools (ILS)	Intermediation services that provide options on weather indices (i.e., a rainfall index) for specific sectors	Weather derivatives have become common in the U.S. and other developed countries, linked to performance of specific industries or sectors (i.e. agriculture).	Can be used at a sector or company level. Enables access to financial markets. Can allow better planning and budgeting at the national and company level.	Significant barriers to entry for developing country governments (see above). No necessary focus on vulnerable populations Requires pre-existing weather index

Name of the Tool	Category	Description	Application examples	Advantages	Challenges
			However, there have been efforts to build the weather derivatives market in developing countries, one of the first being in Malawi to protect maize protection from drought (rainfall index)		
Early Recovery vouchers	Hybrid tool	Early recovery vouchers (a) provide eligible households with an insurance policy guaranteeing immediate disaster payments in cash following disasters caused by natural hazards and (b) can be conditional on recipient households participating in risk reduction and resilience building measures.	ERVO-like schemes are being piloted in China, Peru, Mexico's CADENA system	Specifically target poor households to ensure direct and timely assistance. Have resilience building measures as a precondition to receiving the vouchers. Can be integrated into existing safety-net and cash-transfer programmes, especially for the identification of eligible households. Lower basis risk than Index-Based Insurance, as it focuses on high covariate risk and can be used for entire regions regardless of economic sector	Not a 'profitable' form of risk transfer so would have to be substantially reliant on government or donor funding. The challenge of finding an appropriate index with a low basis risk for the recipient households
Informal risk pooling	Alternative risk transfer tools	Informal risk transfer tools in the form of community risk pools.	Informal caste-based risk pools in India.	Highly tailored to existing institutions, norms and practices of	Unlikely to insure against aggregate risks.

Name of the Tool	Category	Description	Application examples	Advantages	Challenges
				communities Wide scope – can insure against aggregate risks as well as idiosyncratic risks (though far less common) Flexible	

5.1 Tool Kit for DRF

The Asian Development Bank (ADB) has developed a diagnostic framework with a tool kit to provide the basis for new or deepened DRF engagement by international partners, as part of the broader DRM and/or public financial management dialogue. It focuses on the following six axes of relevance for the development of disaster insurance and capital market solutions:

(1) Government policy in the development of risk transfer instruments for DRF;

(2) Economic conditions and other support functions that influence the decision for retaining the risk;

(3) Disaster risk product availability and affordability;

(4) Credibility of the private sector offering risk transfer solutions, covering aspects such as the regulatory environment, the solvency of risk carriers, the reputation of insurance and capital markets, and the availability of infrastructure;

(5) Social protection policy; and

(6) Competition to the formal sector from informal and unlicensed providers, recognizing that insurance credibility and resilient insurance providers are important, and examining licensing and supervision of insurance providers by the regulator [ADB, 2020a].

The tool kit collects the information as shown in **Table 3** hereunder:

The above report presented a comprehensive country diagnostics framework that can be applied to support countries in assessing and strengthening their financial management of disaster risks. It focuses on the state of the enabling environment and opportunities for its enhancement to support the increased availability and uptake of insurance and other risk transfer instruments. The framework enables the identification of gaps between international good practice in disaster risk financing and its application in a particular country. It further provides an enhanced understanding of the demand and supply factors shaping the related enabling environment, including potential barriers to the more effective use of disaster risk financing instruments [ADB, 2020].

This framework is useful for all countries including India, to identify the gaps in disaster risk financing mechanisms while following the international good practices.

5.2 Catastrophe Bonds (CAT Bonds)

The Catastrophe Bonds or CAT Bonds are a type of Insurance Linked (Investment) Securities (ILS) allowing the transfer of risks to investors. The issuers are normally governments, insurance and reinsurance companies. These bonds can be used to manage risks that are associated with catastrophic events. For the investor, buying the Bonds means that they may get high returns for their investment, which is not subject to financial market fluctuations. In case a catastrophe or event occurs, the investors will lose the principal they invested and the issuer (often insurance or reinsurance companies) will receive that money to cover their losses.

Table 3: Landscape of Disaster Risk [ADB, 2020b]

Examining the Full Sovereign Disaster Risk Financing Landscape
The disaster risk financing diagnostic tool developed by the Asian Development Bank and the World Bank assesses levels of financial protection against disasters to identify opportunities for enhancement. It contains questions for finance ministries to extend and expand on country analyses performed under technical assistance projects. These helps build up a more complete picture of the state of sovereign disaster risk financing arrangements, including risk retention mechanisms. The questions cover the following issues:

1.	Assessment of fiscal shocks associated with disasters:
	(a) contingent liability of the government,
	(b) fiscal risk assessment of disaster shocks,
	(c) public disclosure of disaster-related fiscal exposure,
	(d) risk transfer arrangements through capital markets.
2.	Ex-ante disaster risk financing:
	(a) annual contingency budget,
	(b) dedicated budget lines for disaster risk reduction,
	(c) dedicated disaster reserve funds,
	(d) line agency funding,
	(e) contingent financing arrangements,
	(f) insurance of public assets, and
	(g) any other forms of sovereign insurance.
3.	Ex-post disaster risk financing:
	(a) post-disaster budget reallocations,
	(b) external assistance, and
	(c) other ex-post mechanisms.

With insurance and CAT bonds, countries can transfer some of their disaster risk exposure to insurance and capital markets without increasing their sovereign debt. A country pays an insurance premium and in return receives a pay-out if a specified disaster event occurs. The faster pay-out provides much-needed liquidity after a disaster occurs. These bonds allow countries to access a much bigger pool of capital, and in general, longer coverage periods, than conventional insurance. Any counterparty credit risk concern is eliminated, because CAT bonds are fully funded transactions without any default risk.

It is understood from various reports of Aon Securities that the CAT bond sector has surpassed US$100 billion in cumulative issuance since its inception more than 20 years ago. The sector, which began with the placement of a US$45 million all-peril catastrophe bond in 1996, has seen a gradual increase in the use of insurance-linked securities (ILS) by the (re)insurance market, with frequent new records being set in terms of annual issuance volumes. Though Insurance and reinsurance companies are active participants in the CAT-bond market but increasing number of sovereign CAT-bonds have been issued as governments seek ways to transfer risks amid increasing frequency of catastrophic events. The advantages include that they don't impact the credit risk of the issuer.

5.3 Sovereign Risk Transfer

The sovereign risk transfer generally takes a layered approach, providing flexibility through a range of mechanisms to respond to events with different levels of severities as shown in

Table 4: Simplified concepts of layering of financial tools to manage sovereign risk of different frequencies and severities [WB, 2017]

<table>
<tr><th>Hazard Type</th><th></th><th></th></tr>
<tr><td rowspan="2">Low frequency
High severity</td><td>Sovereign Risk Transfer
Insurance, including through risk pools
Derivatives
Cat bonds</td><td rowspan="3">Not all instruments serve the same purpose and governments can take a layered approach to financial protection by combining Instruments with different characteristics.
Such risk layering ensures that cheaper sources of money are used first, with the most expensive instruments used only in exceptional circumstances.</td></tr>
<tr><td>Contingent Credits
Financial instruments that provide access to liquidity immediately after an exogenous shock</td></tr>
<tr><td>High frequency
Low severity</td><td>Budget Reserves/ Budget Reallocations</td></tr>
</table>

The catastrophe risk pools are emerging as a cost-effective vehicle to help countries access rapid financing for disaster response. They allow countries to:

(1) Pool risks in a diversified portfolio;

(2) Retain some risk through joint reserves/capital; and

(3) Transfer excess risk to the reinsurance and capital markets.

By putting a price tag on risk, risk pools also increase the value of risk information and create incentives to invest in risk reduction. Their emergence over the last decade provided governments with access to a new set of instruments to enhance the financial management of climate and disaster risks.

The parametric insurance solutions allow for rapid pay-outs in the event of a disaster, providing liquidity within a couple of weeks to finance rapid response. Beyond parametric insurance, other financial instruments can also be structured and offered by risk pools. For example, Mexico's disaster fund, which acts as a national level risk pool, provides indemnity coverage, where pay-outs are based on actual losses on public infrastructure. The catastrophe risk pools could also be used to aggregate insurance of public infrastructure, or to manage the contingent liability from shock-responsive social protection schemes more cost-effectively. Some countries in South East Asia are also exploring risk pools as a more effective approach to reserves as standby financing. A decade of experience has shown that political commitment, sound operational design, and financial sustainability are at the foundation of successful risk pools. When those foundations are in place, risk pools can in turn generate positive externalities that further enhance their impact, by fostering political, operational, and financial effectiveness. The long-term sustainability of sovereign catastrophe risk pools depends on their ability to generate regular and large enough premium income, possibly with financial support from donor partners; broaden the set of financial instruments offered beyond parametric insurance; maintain strong political commitment; and link financial instruments to pre-agreed post-disaster programs, such as shock-responsive social protection programmes or critical infrastructure recovery programs, to ensure that funds can be efficiently channelled to support targeted post-disaster responses.

The catastrophe risk pools have significantly relied on donor partners for their technical and financing capacity. All sovereign catastrophe risk pools have benefited from donor support to start operations and to remain sustainable during their first years. The donor financing has at various stages covered start-up costs, capitalization, and sometimes (partial) premium financing. The existing sovereign catastrophe risk pools have also required many years of sustained technical assistance from credible third parties; the World Bank Group has assisted the Caribbean Catastrophe Risk Insurance Facility (CCRIF) and Pacific Catastrophe Risk Assessment and Finance Initiative (PCRAFI), and the World Food Program has assisted African Risk Capacity (ARC). The regional catastrophe risk pools require a regional partner organization to facilitate the political and policy dialogue and coordination between participating governments. Given the level of cross-country coordination required to establish and manage such a pool, regional political bodies are essential to facilitate the process. The sovereign pools have relied on their respective regional political organization at various levels.

The sovereign catastrophe risk pools and disaster risk financing solutions more generally require that participating countries be committed to implementing necessary policy reforms. The private sector has contributed to making catastrophe risk pools cost-effective. The private insurance industry has been heavily involved in the preparation and implementation of sovereign catastrophe risk pools. It provides not only risk capital but also technical expertise to inform the design of effective risk pools [WB, 2017b].

Over the past decade, 26 countries of three regions – Africa, the Pacific, and the Caribbean and Central America, have joined as groups and set-up sovereign catastrophe risk pools. The detailed overview of existing sovereign risk pools is given in **Table 5**.

Table 5: Detailed Overview of Existing Regional Sovereign Catastrophe Risk Pools (as of December 2016) [WB, 2017b]

Item	CCRIF (Caribbean)	CCRIF -CA (Central America)	ARC	PCRAFI
Perils	Earthquake, tropical cyclone, extreme rainfall	Earthquake, tropical cyclone, extreme rainfall	Drought, tropical cyclone, flood	Earthquake, tropical cyclone, extreme rainfall
Initial capital	Multi-donor grants via World Bank	Multi-donor grants via World Bank	Interest free loan from 2 partners	Multi-donor grants via World Bank
Participating countries	20 eligible 16 participated 14 purchased coverage in 2016	6 eligible 1 purchased coverage	32 signatories 8 participated 6 in 2016/17	15 eligible 6 participated 5 purchased coverage in 2016/17
Operational entity	Segregated portfolio company, multiple cells	Cell in CCRIF SPC	Class 2 captive insurer	Captive insurance company
Domicile	Cayman Islands	Cayman Islands	Bermuda	Cook Islands
Governance	Board of 5 directors, 2 appointed by Caribbean Development Bank, 2 by CARICOM, and 1 by other 4 Directors	Management Committee for CA cell, under CCRIF SPC board	Board of 7 Directors, appointed by members	Board of 5 Directors appointed by Council of Members
Ownership	Purpose trust	CCRIF Purpose Trust	Mutual insurance company formed at direction of ARC Conference of the Parties	Foundation
Operational staffing	CEO and COO on staff, remainder outsourced to service providers	Operated by CCRIF SPC	CEO and small technical/ operations support team, remainder outsourced to service providers	Operated by Pacific Catastrophe Risk Insurance Company (PCRIC). CEO, remainder outsourced to service providers

Source of Premiums	Initial IDA credits for 4 countries for 3.5 years premium. CDB credits for 0.5 years premium for 8 countries, full grant of premium each year for 1 country	IDA credit for sole current participant (3-5 years premium)	National budgets, grants (1 country)	Grants (first 3 years), national budget, IDA credits
Date of first policies	2007	2015	2014	2013
Cumulative payouts	US$67.3 million	US$0.7 million	US$34 million	US$3.2 million
Avg. aggregate coverage	US$622 million	US$28 million	US$50 million	US$45 million
Source of premiums	IDA credits, CDB credits, grants	IDA credit	National budgets, grants	Grants, national budgets, IDA credits
Reserves	US$117 million	US$1.3 million	US$98.5 million	US$6 million
Form of insurance	Modelled loss parametric	Modelled loss Parametric	Modelled loss parametric	Modelled loss parametric
Modelling	EQ/TC - built for and licensed by CCRIF, available to participants for non-commercial use XSR - in-house	EQ/TC - built for and licensed by CCRIF, available to participants for non-commercial use XSR - in-house	In-house (license owned by ARC Agency), TC and FL will use licensed feed for hazard data	AIR Worldwide model
Pay-out process	Initial estimate in 3-5 days, pay-out made after 14 days (partial pay-outs have been made sooner). Self-certification of loss required	Initial estimate in 3-5 days, pay-out made after 14 days (partial pay-outs have been made sooner). Self-certification of loss required	Pay-out calculated within 10 days of end of risk period (for drought), 7 days for TC/FL.	Pay-outs made within 10 business days.

			Self-certification of loss required. Certified contingency plan also required before pay-out is made.	
Reinsurance summary	Panel of traditional Re-insurers and capital market element, most recently via World Bank CAT Bond	Traditional Re-insurers, separate placement for CA cell	Traditional reinsurance agreement with 24 participants, multi-peril	Panel of 5 Re-insurers
Portion of Agg. Limit Re-insured (2016/17)	25%	66%	41%	90% (to decrease significantly once the facility is fully capitalized in 2017)
Capital/ Reserves (2016)	US$117 million	US$1.3 million	US$98.5 million (Statutory Capital & Surplus as of end-2015)	US$6 million (to increase to US$25 million in 2017)
Associated meso or micro schemes	Two products co-developed by CCRIF, one meso (inactive) and one micro (active), both utilize CCRIF model to some extent, no risk taken by CCRIF to date	n.a.	Licensing for Development initiative allows for use of ARC model to underpin commercial transactions. Revenue to L4D Trust to support ARC, ARC Ltd. could take some risk	n.a.

Notes:	
IDA	: International Development Association
CDB	: Caribbean Development Bank
EQ	: Earthquake
TC	: Tropical Cyclone
XSR	: Excess Rainfall
FL	: Flood
L4D	: Licensing for Development

In Asia, very recently efforts were made by Association of South East Asian Nations (ASEAN) to set up a Pool for their group countries. The South East Asia Disaster Risk Insurance Facility (SEADRIF) was agreed in December 2018 to launch as an ASEAN+3 initiative, with the goal of helping member countries in ASEAN to enhance their financial resilience against disasters. The initiative was supported by the technical assistance of the World Bank and the financial and political support of Japan and Singapore. The SEADRIF is designed as a platform that offers members customized financial solutions to disaster shocks as well as knowledge sharing and technical assistance, including for insurance market development. The first financial programme developed under SEADRIF is a regional catastrophe risk pool for the Lao People's Democratic Republic, Myanmar, and possibly Cambodia. The SEADRIF is also starting to work with middle-income countries in ASEAN [WB, 2019].

6. LESSONS ON RISK POOLS

Policy makers have been advised by the World Bank to keep in mind certain lessons to reap the benefits of risk pools and they are shown in **Table 6**.

7. CONCLUSION

While the economic dislocations caused by COVID 19 certainly will impact negatively on government budgets, this pandemic event will highlight the importance of risk management and the value of insuring against events that can have significant shocks on a nation's economy. Many emerging economies facing the challenge of COVID 19 are also exposed to natural disasters and catastrophic events. With the concern of compound shocks growing, there's an immediate need for governments to place greater emphasis on disaster risk financing. With developing country budgets already stretched by COVID 19, related reductions in revenues and increases in public health expenditures, the benefits of financial support for CAT bonds, related insurance programmes and emergence of regional risk pools become imminent. As budgets and fiscal space getting reduced, financial protection against future shocks like natural disasters is needed now more than ever.

Table 6: Ten Lessons on Risk Pools

1	Pools can succeed only with strong political commitment. Strong political momentum and coordination among participating countries is essential, especially during the design and preparation stage. A strong regional organization is often critical to facilitate political and policy coordination needed between participating governments.
2	Pools often rely on strong donor support. Donors have a key role to play in supporting the development of risk pools with financial and technical resources, and in reducing reliance on unpredictable post-disaster humanitarian assistance.
3	Pools can strengthen disaster preparedness and crisis response. Policy makers need to be ready to manage the impacts of residual risks through pre-agreed post-disaster plans, backed by pre-planned financing.
4	Pools can foster policy dialogue on risk management and risk ownership. They offer a vehicle to anchor financial planning; contingency planning; ownership of and collaboration on the climate risk management agenda between and within countries; and risk-informed investments.
5	Pools can maximize impact by developing pre-agreed disaster response plans. Linking financial instruments, including risk pools, to pre-agreed post-disaster programs, can help ensure that funds are disbursed rapidly and effectively.

6	Pools can create public goods. Risk pools can drive improved insurance literacy, increased institutional capacity, and the availability of disaster risk data and modelling. For example, the Pacific Risk Information System (a platform that includes an exposure database of over 4 million assets in the region) and its associated catastrophe risk model have been used by domestic insurers and brokers to inform their underwriting and pricing decisions. In Fiji for example, the model was used to inform the provision of catastrophe risk insurance for hotels and resorts.
7	Pools can offer cost-effective insurance solutions. By helping countries develop standard products based on their respective needs, and structuring a portfolio of diversified country risks, risk pools offer larger transaction sizes that are more attractive to global reinsurance and capital markets. Additionally, risk pools can reduce premiums by reducing the cost of capital, operating costs, and the cost of risk information.
8	Pools should be part of a comprehensive financial protection strategy. The parametric insurance products offered by risk pools provide rapid (but limited) liquidity in the immediate aftermath of infrequent and severe disasters. Other financial instruments, such as contingency funds and contingent loans, can be used to finance recovery and reconstruction efforts, as well as the cost of more frequent disasters. Governments can strengthen financial resilience by combining financial instruments that address different needs and have different cost implications.
9	Pools require up-front payment of an insurance premium, facilitating a shift toward proactive risk management. Participating countries have to pay upfront an insurance premium that reflects their actual risk exposure in exchange for the insurance coverage, thereby shifting payments to take place in predictable instalments before disaster strikes. It may be challenging for countries that previously relied on donor support to start paying an insurance premium for disaster risks with national resources. However, moving in this direction, even partially, can provide the right incentives for proactive planning and risk-informed investments in risk reduction.

10	Pools can be sustainable only with more formal and predictable approaches to premium financing. Policy makers tend to see allocating budget for the payment of premiums as not generally a permanent part of budgetary processes. This is when concessional insurance through targeted premium subsidies or concessional loans can be useful. Concessional insurance can help countries secure premium financing for several years while they progressively include premiums as an item in their national budget [WB, 2017].

The governments should consider ways to identify and reduce the underlying drivers of disaster risk to reduce the impact. The risk pools (with sovereign risk pools) along with other disaster risk finance and insurance solutions, complement risk reduction by helping governments address those risks that can't be mitigated. These measures work proactively for risk management rather than raise funds after a disaster strikes. The Working Group of IRDAI's recommendation to set up an Indian Pandemic Risk Pool is a right step taken in that direction at an appropriate time.

The diversification among participating countries in the regional risk pools can create a more stable and less capital-intensive portfolio as it is not expected that several countries will face the same challenge (risk) in the same year. This will become cheaper to reinsure. These regional risk pools can create some incentives for countries to invest in risk reduction since risk is priced. This act may evoke some interest among donor countries to provide assistance wherever possible.

It is hoped that the disaster risk financing and transfer to capital markets in India also will help to transfer considerable risk as the market is well matured. The authorities need to take steps to develop a framework for implementation with due regulatory support and approvals along with legal authority. This may be an immediate necessity to manage the DRF.

A Regional Risk Facility is needed for South and Central Asian countries as the facility can provide a better risk spread and aggregation. It is relevant to conclude that India is well poised as the best country to take a lead in this regard and initiate a dialogue with likeminded disaster-prone countries of the region right away. The geographical position of India with its well-equipped administrative structure is the positive factor for such an endeavour. As this region too is facing lot of climatic challenges leading to many disastrous events, it's an opportunity to draw the attention of United Nations with its specialized agencies as well as the international financial institutions for provision of a possible technical expertise and financial support through a regional risk pool under Indian stewardship.

References

1. ADB, (2020a), "Assessing the enabling environment for Disaster Risk financing: A Country Diagnostics Tool Kit," Asian Development Bank, June 2020, pp 3-4
2. ADB, (2020b), "Assessing the enabling environment for Disaster Risk financing: A Country Diagnostics Tool Kit," Asian Development Bank, June 2020, p 4
3. Giddy,I., (2020), "Alternative Risk Transfer"

   http://pages.stern.nyu.edu/~igiddy/articles/alternative_risk_transfer.htm#:~:text=Alternative%20Risk%20Transfer%20(ART)%20is,the%20insurer%20and%20the%20insured

   Accessed on 15 August 2020
4. IRDAI, (2020), *Report of the Working Group to Study and Make Recommendations on Formation of Indian Pandemic Risk Pool, September 2020, pp.4, 6-7 and 35*
5. Mathur,S., (2016), *"Role of Insurance in Disaster Management," IRDAI Journal, Vol.XIV, No.3, March,2016, p 14*
6. Meena,S.C., (2018), Disaster Funding Arrangements in India

   http://www.arthapedia.in/index.php?title=Disaster_funding_arrangements_in_India

   Accessed on 16 September 2020
7. Montier,E., Harris,C., Ranger,N., (2019), "Disaster Risk Financing in Concert: How Coordinated Disaster Risk Financing can save more lives," A Start Network, September 2019, page 5
8. NDMA, (2019), Expression of Interest

   https://ndma.gov.in/images/tenders/REOI_CMhRFS.pdf

Accessed on 16 September 2019

9. OECD, (2015), Disaster Risk Financing: A global survey of practices and challenges, Accessed on 1 September 2020

10. UNDRR, (2015), United Nations Disaster Risk Reduction

    https://www.undrr.org/about-undrr

    Accessed on 26 September 2020

11. UNEP, (2014), "Building disaster-resilient communities and economies," UNEP Finance Initiative, June 2014, p 10

12. UNU, (2017), "The Role of Insurance in Integrated Disaster & Climate Risk Management: Evidence and Lessons Learned," United Nations University-Institute for Environment and Human Security (UNU-EHS), Report No.22, October 2017

13. WB, (2017a), *"Sovereign Catastrophe Risk Pools: World Bank Technical Contribution to the G20," Report of the World Bank, 2017,*

    https://openknowledge.worldbank.org/handle/10986/28311;

    Accessed on 26 September 2020

14. WB, (2017b), "Sovereign Climate and Disaster Risk Pooling: World Bank Technical Contribution to the G20," World Bank Report; IBRD/IDA or World Bank; 2017

    https://www.worldbank.org/en/news/feature/2017/11/14/what-makes-catastrophe-risk-pools- work

    Accessed on 19 August 2020

15. WB, (2019), "Boosting Financial Resilience to Disaster Shocks: Good Practices and New Frontiers," World Bank Technical Contribution to the 2019 G20 Finance Ministers' and Central Bank Governors' Meeting, 2019 International Bank for Reconstruction and Development / International Development Association, The World Bank, p 28

16. WB, (2020), Disaster Risk Financing and Insurance Program

    https://www.worldbank.org/en/programs/disaster-risk-financing-and-insurance-program

    Accessed on 15 August 2020

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Role of Geo-Spatial Technology in Drought Management

Abstract: Droughts continue to be a strong determinant of the performance and sustenance of agriculture in India. Their management is challenging because of diverse weather, water availability conditions, soils and crops. Satellite-based drought monitoring initiated by National Remote Sensing Agency (NRSA) in 1989 has become one of the most successful remote sensing applications in India. With proven indices – NDVI, LSWI, SASI and RADAR Backscatter available in moderate spatial and temporal resolutions and with geospatial products on soil moisture and rainfall, geospatial technology has contributed to new information and knowledge for improving drought assessment, declaration and management in the country. Satellite-based maps of resources and high-resolution satellite images are being used for the development, implementation and impact assessment of long-term Drought Management measures. Smart phone-based monitoring of field level assets has become a successful technology application. The crop insurance mechanism has been strengthened to become an effective drought risk mitigation tool. Abundantly available satellite data, an increasing network of weather observatories, mobile-based fast and efficient field data collection systems and easily accessible advanced techniques of data analysis signify enormous scope for establishing a digital agricultural ecosystem for drought management in the near future. This paper narrates the role of geospatial technology, particularly remote sensing, in drought management in the country.

Key words: Drought, Agriculture, Meteorology, Satellites, RADAR, Natural calamities, disaster risks

1. INTRODUCTION

Agriculture and its allied sectors engage more than 50% of the population in India but contributing only 16% of GDP. The total geographical area of the country is 328.7 million hectares, of which 141 million hectares is the net sown area and 198 million hectares is the gross cropped area, with a cropping intensity of 142% approximately [DACFW, 2020]. Exposure to multiple disasters, crop risks and non-remunerative prices characterize the current distress situation in the agriculture sector in the country. Drought is a frequently occurring hydro-meteorological disaster affecting the farm sector, animal husbandry and socio-economic structure of the economy. Uncertain monsoon, unreliable surface water supplies, depleting ground water levels and increasing land degradation are posing a serious threat to the sustenance and economic prosperity of the farm sector in the country [Samra, 2006]. Droughts have thus become a serious limiting environmental factor for agricultural production in the main cropping season of India. While the effects of droughts are multidimensional and interlinked in nature, the immediate manifestation of drought is seen in agriculture. With reduced water availability, crops suffer from abiotic stress leading to disruptions in growth and final yields. The other effects of drought, such as fodder shortage, labour migration, etc. are closely related to their impact on crops. Therefore, by minimising the crop losses due to droughts through effective management practices, the other interlinked effects can be reduced substantially.

Drought management includes both short and long-term measures. The reactive or crisis-oriented approach aims at in-season drought management through loss minimization strategies, calling for a sound operational drought monitoring system. Regular monitoring of drought conditions, objective assessment of their impact on crops during the season and enriching farmer advisories constitute an ideal drought monitoring system. Proactive or mitigation oriented drought management includes structural interventions related to soil and water conservation and hence needs information on the hotspots of droughts in terms of risk and vulnerability.

Considering the multidimensional nature of drought management, the need for new indicators and tools has been widely recognized to assess drought occurrence, distribution and impact. This paper discusses the role of geospatial technology particularly remote sensing in drought management, covering the current status of technology utilization and the possible near-future developments.

2. DROUGHT MANAGEMENT: NEED FOR GEOSPATIAL TECHNOLOGY SUPPORT

Successful drought management depends on drought monitoring ability, relief management system and drought-proofing efforts. These three subsystems of drought management complement and supplement each other. A robust system of drought surveillance immensely benefits relief management. Long term surveillance data is useful to prioritize regions for drought-proofing. Effective drought-proofing reduces drought impacts during the season. Broadly, the following functional needs of the current drought management system are being supported by the geospatial technology:

(1) Drought monitoring and early warning,

(2) Impact assessments,

(3) Drought declaration,

(4) Vulnerability and risk assessment,

(5) Prioritisation of regions/sub-regions for undertaking drought proofing measures,

(6) Resources mapping and sustainable development planning, and

(7) Monitoring and evaluation of development programs/ projects.

The data and information requirements and technology support for drought management are summarised in **Table 1**.

Table 1: Information needs for Drought Management

S. No.	Drought Management Activity	Information Needs	Geospatial Technology Support
1.	Drought monitoring, early warning and impact assessment	Delay in sowing time, reduction in crop sown area, crop stress affected areas, yield reduction, etc.	Satellite indices on crop health, soil moisture, weather indices, and Mobile Apps
2.	Long term drought management	Hazard, vulnerability and risk assessments	Time series data on satellite indices, climate data, soil moisture, cropping pattern, soil, irrigation and socio-economic parameters
3.	Development, implementation and evaluation of drought-proofing measures	Thematic layers of resources, prioritization of regions, asset mapping	High-resolution satellite data and thematic layers, smart phone-based geo-tagging

3. DROUGHT MONITORING AND EARLY WARNING

Monitoring and assessment of drought conditions and timely dissemination of information to stake holders constitute the most vital part of the drought management system. Inadequate drought monitoring systems in terms of unreliable data points and a lack of standard procedures to calculate drought indices can lead to inefficient management strategies. Therefore, a sound, objective and economically viable drought monitoring system at national to regional to local levels is a well-recognized need. Traditionally, drought conditions are characterized by data on meteorological parameters such as rainfall and aridity and agricultural parameters such as sown crop area and crop yield. These datasets are non-spatial as well as inadequate to represent drought conditions at the required granularity. Unlike point observations of ground data, satellite data provide direct spatial information on vegetation stress caused by drought conditions. Remote sensing technology offers efficient, timely and cost-effective methods for mapping, monitoring and management of agriculture.

3.1 Satellite based drought monitoring in India; evolution and current status

After the phenomenal drought during 1987, which affected most parts of our country, the National Remote Sensing Agency (NRSA) started research activities on the use of space technology for drought monitoring under the leadership of Dr. S. Thiruvengadachari which resulted in a national level drought monitoring project named as the "National Agricultural Drought Assessment and Monitoring System (NADAMS)". The operational services from NADAMS project commenced during Kharif 1989, with issuing biweekly drought bulletins from June to November, depicting the districts under different categories of drought intensity. NOAA AVHRR 1 km Normalised Difference Vegetation Index (NDVI), rainfall and sowing data of districts were mainly used for drought assessment. From 2004, NADAMS project was brought under the Disaster Management Support Program (DMSP) of ISRO. In 2012, the project was institutionalized into Ministry of Agriculture, Govt. of India.

NADAMS project has undergone many methodological improvements, from time to time keeping pace with developments in space technology and user requirements. With the availability of WiFS data from IRS satellites from 1995, spatial details of drought assessment improved significantly from 1 km to 188 metres. Launch of Resourcesat satellite during 2003 gave a major thrust to NADAMS project. It carried Advanced Wide Field Sensor (AWiFS) providing data in 56m resolution and in four spectral bands including a SWIR band. AWiFS data utilization resulted in two benefits namely: (a) sub-district level drought assessment and (b) one additional drought index - NDWI. Another development was utilization of Terra MODIS data which has unique features of large swath, daily coverage and additional spectral bands and indices, despite coarse spectral resolution at 250m, for drought assessment from 2005.

The emphasis on an integrated approach in NADAMS had started in 2006 and by 2008, an operational approach with a combination of multiple indices and bio-physical products with augmented ground database on rainfall and crops was put into practice.

From 2010, an angular index "Shortwave Angle Slope Index (SASI)" derived from NIR and two SWIR bands has been adopted in NADAMS. SASI is more sensitive to surface wetness/dryness than

NDWI/LSWI. Studies by the NRSC team revealed chronological synchronization between: (a) rainfall occurrence, (b) decrease in SASI values, and (c) increase in crop sown area during the season. Positive to negative transformation of SASI in the seasonal profile indicate dryness to wetness shift and this property of SASI has been exploited to assess the area favourable for crop sowing and commencement and progression of crop sowings.

Realizing the importance of drought information and maturity and soundness of NADAMS project, the Department of Agriculture and Cooperation under the Ministry of Agriculture started implementing this project through its attached office - Mahalanobis National Crop Forecasting Centre (MNCFC), New Delhi, from 2012, with technology transfer and capacity building extended by NRSC. This act of absorbing a technology project into the User Department has enhanced the end-use of drought information products. Thus, NADAMS project has become one of the remote sensing application projects that has been successfully institutionalized in the User departments [Seshasai *et al*, 2013]. Since then, NRSC has been working on developing new techniques of drought assessment. Thus, India has become one of the few countries in the world that uses space and other technologies including land-based observations for generating regular updates on drought conditions.

Satellites/sensors data that are currently used for drought monitoring include resources at AWiFS, Sentinel SAR and MSI and Terra MODIS and the indices for drought detection are summarized in **Table 2**. Considering the strengths and limitations of each index, combination of indices is being used in NADAMS project to make drought assessment more responsive to the actual field situation.

Table 2: Satellite indices for drought monitoring in India

S.No.	Indices	Spatial resolution (m)	Significance
1.	NDVI	10-1000	Crop vigour index
2.	LSWI	10-1000	Surface/crop moisture status
3.	SASI	10-500	Surface/crop moisture index

4.	RADAR Backscatter	10-20	Canopy volumetric scattering sensitive to biomass
5.	Surface soil moisture	10-25 km	Passive microwave emissions
6.	Root zone soil moisture	1-9 km	Hydrological modeling with satellite based inputs

Soil moisture plays a key role in the success of the crop. Surface soil moisture data derived from passive microwave AMSR-E sensor are being used to detect drought conditions in the early part of crop season when the optical vegetation indices are of limited use. Since root zone soil moisture data is more useful than surface soil moisture, a soil water balance model was developed under NADAMS project which runs on a daily basis to provide root zone soil moisture throughout the kharif season. The root zone soil moisture for the selected crops is helpful in identifying the exact period and duration of stress in a particular region. Thus, soil water balance model has been a very important component in the NADAMS project.

Synthetic aperture RADAR data can be exploited for the early season drought detection, owing to its sensitivity to the dielectric properties of target, especially in case of unavailability of optical data due to cloud cover. Early drought detection using SAR data can be hypothesized on two bases: (a) as soil moisture increases (keeping the surface roughness same), backscatter from target also increases; and (b) as crop grows, backscatter also increases (due to increase in canopy moisture/ roughness) till onset of senescence stage. Dry soils respond with low backscatter intensity. Early season drought conditions in 2019, in some of the districts of Maharashtra were successfully assessed by NRSC using the back scatter response patterns of current and historic years.

3.2 National Drought Manual 2009 and 2016

Ministry of Agriculture, Government of India by constituting an Expert Committee developed the National Manual for Drought Management in 2009 in order to streamline drought assessment procedures being followed by states. The manual provides guidelines to the States for operational assessment of drought conditions in a more objective manner with a set of indices. The use of satellite-based crop condition index, as a drought indicator, has been recommended in the manual. This manual has improved the drought assessment system in the country. The National Drought Manual was revised in 2016 to further improve the assessment mechanism considering the technology developments in satellite data and weather data availability. Many more number of drought impact indicators are included to make the drought assessment more comprehensive and scientific. All the states are now following the guidelines for drought declaration and relief assessment. The drought manual can be accessed at from the NIC website [AC,2020]

3.3 Mobile Technology

Reliable field data on crop status during the season are very essential for any agriculture monitoring and impact assessment system. The advent of mobile technology has immensely benefitted the field data collection in Agriculture. Mobile Apps facilitate efficient field data collection covering a large number of locations in less time. It provides objective evidence on the prevailing agricultural conditions. Library of field information during crop growing period can be generated using Mobile Apps. Mobile- app collected crop field data is useful for multiple purposes: (a) general crop surveillance for the Central Ministries, States, Insurance and Reinsurance companies, (b) assessing crop losses from localised crop damages, mid-season adversaries, (c) disasters (drought and flood) impact assessment. In the drought manual, it is recommended to undertake field data collection using Mobile Apps, in the blocks/ taluks identified as drought-affected based on drought indicators, to provide additional evidence on the crop loss. Thus, Mobile technology has strengthened the drought declaration mechanism.

3.4 Success Stories of Drought Monitoring by States

In recent years, many States are adopting systematic procedures for improving the data collection related to drought indicators. Drought assessment procedures have been made more rational and objective. Two success stories from States based on best practices are presented below.

(a) Karnataka

Karnataka is the first state in the country to constitute "Drought Monitoring Cell (DMC)" in 1988 to focus on improved drought assessment based on multiple indicators. DMC was subsequently transformed into Karnataka State Natural Disaster Monitoring Centre (KSNDMC) in 2007 covering other disasters also. NRSC and DMC worked together for many years since 1998, to undertake satellite-based drought assessment. With technology transfer and capacity building, KSNDMC had become self-reliant in using remote sensing technology, about a decade back. By establishing dense network of rain gauges and weather stations followed by data analysis platforms, KSNDMC generates multiple drought indicators at Hobli and Village levels. Automated data analysis, visualization and alerts generation have been achieved. Tracking drought conditions at the village level and integrating such information with farmer advisories have immensely strengthened the drought management in the State. Thus, Karnataka has become a model state in drought monitoring and management. More information about drought assessment in Karnataka is available in public domain [KN, 2020].

(b) Maharashtra

MahaMADAT is a drought assessment system developed by Maharashtra State Remote Sensing Centre with the support of Departments of Disaster Management, Relief & Rehabilitation and Agriculture, Government of Maharashtra. MahaMADAT is a web-based Geoportal hosting data from various sources for visualization, query, monitoring and management for timely dissemination of the drought information. A systematic database of drought indicators prescribed in the National Drought Manual 2016 is maintained in the portal. Android-based Mobile Apps for ground truth data collection along with time stamped photographs/videos are also part of the portal. MahaMADAT permits objective assessment of drought conditions from time to time with customized visualization of the anomalies by different drought indices.

4. LONG TERM DROUGHT MANAGEMENT

Information on the drought vulnerability status of different sub-regions is extremely useful for prescription, development and implementation of long term drought management measures. Different areas are differentially exposed to drought and have different levels of vulnerability mainly on account of skewed development processes of environment, socio-economic, infrastructure, etc. Climate variability observed in recent years, cropping pattern changes, irrigation development, etc. are changing the agricultural scenario in the country leading to changes in the vulnerability profiles of agricultural areas. These changes in weather, soil and crop factors and their interactions indicate the need for the development of a new set of criteria for delineation of drought-prone/vulnerable areas.

4.1 Agricultural Drought Vulnerability

By using time series satellite data, climate data, crop yield data, soil, ground water, irrigation layers and land holdings data, NRSC generated the key components of agricultural drought vulnerability i.e. exposure, sensitivity and adaptive capacity, through composite indexing approach. Agricultural drought vulnerability index is derived by summing up exposure and sensitivity components and subtracting adaptive capacity component. Thus, a bio-physical composite index of agricultural drought vulnerability status was generated at block/mandal level for selected states [Murthy *et al*, 2015]. The agricultural drought vulnerability status maps for different states have been shared to the User Departments. Based on vulnerability status, blocks within each district have been prioritized for undertaking drought management action plans.

4.2 Integrated Mission for Sustainable Development (IMSD)

Integrated Mission for Sustainable Development (IMSD) project is a unique application of Remote Sensing to generate action plans to combat drought on a long term basis with site-specific solutions for the drought stricken areas of the country. Key parameters that were integrated are soils and soil depth, slope, nature of underlying rocks, groundwater levels, rainfall and drainage density, in addition to socioeconomics and current cropping practices. The concept of sustainability is to monitor the effectiveness of the actions on integrating strengths of natural resources for development [Rao 1998]. From drought proofing point of view, identification of check dams at right locations to raise ground water levels to save the crop was one of the recommendations in several action plans. It was tested in six drought prone districts over a period of five years with success. It was a Mission launched by ISRO, identifying NRSC as a nodal agency to provide technical and managerial guidance in the program that involved state remote sensing centers, state government departments and district level officials. IMSD was a test of technical, managerial and conceptual strengths of NRSC in providing grassroots level solutions through remote sensing applications. Under the program, resource maps and action plans that enable watershed development were generated. By 1994-95, the project had grown in strength and action plans were discussed at district levels. The Integrated Mission was executed in 25 states in three phases covering about 25% of the country.

4.3 Monitoring and Evaluation of Drought Management Interventions

Long-term drought management measures mostly include structural interventions related to soil and water conservation besides management prescriptions related cropping patterns and water management. Structural measures are capital intensive in nature. Assets created at ground level and benefits accrued from time to time through the structural interventions are to be assessed for their viability. There are numerous schemes on watershed development, minor irrigation development etc being implemented across the country. All these schemes/interventions need systematic database, continuous monitoring and objective assessment of their impacts on crop farming. Geo Information-Communication Technology (Geo-ICT) based framework offers new dimensions to monitoring and evaluation system and permits participation of all stake holders. NRSC created this framework of monitoring and evaluation on its Bhuvan geoportal. Multi-scale and multi-source information in the form of maps and tables from multiple stakeholders are converted in to structured database. Some of these thematic layers include drainage (1:10,000), wastelands (1:50,000 for 08-09), geomorphology (1:50,000 for 05-06) and salt affected soils (1:50,000 for 05-06), Soil related database layers (Texture, productivity, erosion and depth) at coarse scale (1:500,000) and cadastral boundaries wherever available. Remote sensing and GIS put together enable high degree of information fidelity and infuse strong sense of temporal and spatial clarity essential to visualize, record, analyse and strategize the operations involved in Watershed management [Dwivedi and Ravisankar, 2010].

Satellite images of high and moderate resolutions capture information on the status of the watershed in terms of water bodies, crop area and vigour, vegetation status, etc. before and after that development program. Mobile App collected field data points and weather data strengthen the assessment. NRSC's Bhuvan framework of planning, monitoring and evaluation of agriculture and rural development programs at grassroots level, has become a success story of technology application. Such an application has enhanced transparency and stakeholders' participation in the implementation of various projects/schemes.

5. CROP INSURANCE

In the current system, drought risks faced by farmers during the season are minimized in two ways, namely: (a) relief from the Government based on drought declaration and (b) compensation from the Insurance Contracts. Crop insurance has become an indispensable risk reducing instrument in Agriculture which is exposed to multiple hazards leading to frequent crop losses. Pradhan Mantri Fasal Bima Yojana (PMFBY), being implemented in most parts of the country, from kharif 2016, is a major step towards improving agriculture insurance in the country. Small field sizes, high variability in yields and frequent weather aberrations have made technology application inevitable for the successful implementation of crop insurance. PMFBY guidelines (available at agricoop.gov.in) have indicated that the use of technologies in crop insurance is mandatory. Remote Sensing, Mobile, Geospatial tools and drones are identified as potential technologies to support crop insurance system in the country.

Technology-based interventions are relevant to all segments of crop insurance value chain starting from insurance pricing, risk assessments, end of season crop performance assessment and timely settlements of claims. Successful use-cases of technology interventions in PMFBY developed by NRSC include risk-based clustering of districts for insurance pricing, smart sampling for improving crop yield estimation, assessment of affected kharif crop area due to unseasonal rains in Maharashtra, development of yield proxies, impact assessment of weather extremes, Mobile App development for field data collection, etc. There are many other opportunities for technology utilization under PMFBY such as optimising field sampling for yield estimation and assessing crop losses from weather extremes.

6. FUTURE DEVELOPMENTS

Considering (a) technology development in the near future, (b) current information gaps and asymmetries for drought management, (c) large pool of agriculture-related data already available with different stake holders and (d) current capabilities of digital technologies, the following near-future requirements and developments in the domain of drought management in India are visualized.

6.1 Drought Surveillance System

Timely and objective crop surveillance information is fundamental to minimise the impact of recurring crop risks. There are isolated efforts by various agencies to provide these kinds of information products and services, but the challenge lies in synergising these efforts in to an integrated and holistic mechanism. Drought surveillance system and automated alerts generation would hugely strengthen agro-advisories, disaster relief, crop insurance, etc. Large streams of data from multiple sources – satellites, weather stations, Mobile Apps, etc are to be processed, combined to investigate the associations, establish relationships, perform predictions on crop health and risk occurrence. Digital crop area maps using satellite data during the season are vital inputs for crop management advisories and production estimations. A combination of mobile-based crop surveillance, satellite indices and weather-based indices enables comprehensive crop health information products.

The drought surveillance system is the prime requirement for the country because all the stake holders in agriculture are increasingly looking for data-driven up-to-date information and solutions.

6.2 Composite drought index

The development of a composite index for drought severity assessment by integrating the data from different sources is widely recognized to enhance the scope of drought management. There is a need to arrive at a scientifically true measure cutting across various rainfall zones and socio economically acceptable indicator of drought for the country. The index should give appropriate weights to the rainfall, soil moisture and crop condition. This index allows incorporating variability of soil parameters, crops and weather, which lead to a better assessment of drought over the growing season. Satellite indices are good proxies manifesting drought impacts on crops. Thus, a drought index which encompasses rainfall, soil moisture and crop condition would become complete and comprehensive. Such index if available at local scales such as at villages or blocks would greatly enhance the capabilities of all stake holders in drought management.

6.3 Early Warning

Early warning systems help in formulating drought intervention strategies that respond to the needs of the people and enables individuals/community to face the risk with reduced damage. Objective and scientific information on the possibilities of the occurrence of drought situation in a given area enhance the credibility of early warning signals. A good early warning system should have a composite database on meteorological conditions including long and medium range weather forecast, agricultural situation, production estimates, availability of drinking water, fodder, price trends of food and feed, etc. The physical aspects of an early warning system should be able to provide information on the spatial extent of the droughts, duration of the droughts, time of occurrence of droughts in relation to the crop calendar and the severity of the droughts. Procedures have to be developed for early droughts detection and assessing the quantitative impact of drought on agricultural production through the use of satellite data and assimilation of data from ground segments, routinely collected by various agricultural related departments of the country.

6.4 Digital platforms for monitoring and impact assessments

A large number of Organisations are associated with data collection in agriculture serving multiple purposes, leading to a big pool of multi-source data. Millions of geo-tagged data is currently available with different agencies in the country. Bhuvan geo-portal of NRSC hosts a large amount of spatial and non-spatial data comprising satellite-based thematic layers, soil health card, geo-tagged assets of different schemes, etc. which has direct utility in agriculture. Similarly, massive volumes of data are available with many other Agencies. Abundantly available grass root level datasets, rising opportunities for enhancing data collection mechanisms in terms of timeliness and coverage signify favorable environments for establishing digital platforms for monitoring and impact assessments of drought-proofing measures happening at the field scale. Capabilities of high-resolution satellite data sets for field-scale level monitoring have already been demonstrated in the country. Such digital platforms would greatly increase the transparency and efficiency of monitoring systems thereby saving a lot of money and resources, besides providing realistic impact assessments.

6.5 Institutional Frame Work

Drought management requires joint efforts of individuals/ institutions originating from multidisciplinary aspects and together should evolve a mechanism to understand the inter relations of various aspects and generate the action plan. The major challenge lies in bringing these groups together for augmenting the drought management chain. Such collective intellect should address various issues such as identification of various constraints, research needs, integration of science and policy, formulation of drought plan, creation of public awareness, implementation of planned activities either short term or long term etc.

7. CONCLUSION AND WAY FORWARD

Informed decision making for drought management, good governance of drought relief measures and sound policy making are possible only if reliable data and analysis tools are available. Space technology and other data-centric technologies have strengthened drought management from time to time by offering new datasets, information products, services and planning tools, benefitting all the stake holders.

It is now widely recognized that digital technologies and science-based planning would continue to be the requirements for drought management in the country. Still, there are enormous opportunities for enhancing the utilisation of satellite remote sensing and GIS technologies towards evolving a more robust drought management system in the country. The benefits of these new technologies are yet to reach the farmers. Spatial analytics, data mining, data engineering, evidence-based tools, etc. could churn out useful information products. Many farmer-centric services such as weather advisory, pest/management and market advisory could be improved drastically by bringing new forms of knowledge and tools through digitalisation and datafication.

Mainstreaming digital technologies into drought management systems needs the committed participation of multiple stake holders - farmers, input suppliers, traders, administrators, researchers representing private sectors, governments and non-profit organizations. Benefits of technology are effectively reaped only when the institutional mechanism is in place.

A National Policy for Drought-Related Data Collection, maintenance and analysis need to be formulated and implemented. Develop the culture of data collection among the states, by showcasing the best practices. Standard operating procedures and capacity building efforts would enhance technology adoption.

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References

1. AC, (2020), Drought Management

   http://agricoop.nic.in/divisiontype/drought-management.

   Accessed on 10 October 2020

2. Das,P.K., Murthy,C.S., and Seshasai,M.V.R., (2013), "Early-Season Agricultural Drought: Detection, Assessment and Monitoring using Shortwave Angle and Slope Index (SASI) Data," *Environmental Monitoring and Assessment Journal*, DOI: 10.1007/s 10661-013-3299-8

3. DACFW, (2020), Annual Report 2019-20

   www.agricoop.nic.in

   Accessed on 10 October 2020

4. Dwivedi,R.S., and Ravishankar,T, (2010), "Watershed Management : A Geospatial Technology Perspective," *Watersheds: Management, Restoration and Environmental Impact*, Editor Vaughn, J.C., ISBN:978-1-61668-667-3, pp 116-159

5. KN, (2020), Rainfall Atlas of Karnataka, KSNDMC Pub

   www.ksndmc.org.

   Accessed on 10 October 2020

6. Murthy,C.S., Laxman,B., and Sesha Sai,M.V.R., (2015), "Geospatial analysis of agricultural drought vulnerability using a composite index based on exposure, sensitivity and adaptive capacity," *International Journal of Disaster Risk Reduction*, 12, pp 163–171

7. Rao,D.P, (1998), "Remote Sensing and GIS for Sustainable Development – An Overview," International Archives of Photogrammetry and Remote Sensing, Vol. XXXII, Part 7, pp 156-163

8. Samra,J.S., (2006), "Droughts, Risks, Insurance and Management in India," *Drought Management Strategies in India*, Editors J.S. Samra, Gurbachan Singh and J.C. Dagar, ICAR Pub., pp 277

9. Seshasai,M.V.R., Murthy,C.S., Chandrasekar,K., Jeelani,M.A., and Das,P.K., (2013), "Agricultural drought: Assessment and monitoring," *NNRMS Bulletin*, Department of Space, Government of India, 38, pp 93-105

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Medical Readiness in Disaster Management

Abstract: Disasters have affected more than 26 lakh people over the last decade. As environmental degradation and the pace of urbanization accelerate in the 21st Century, the nature, frequency and intensity of disasters are only set to increase. Protecting populations from disasters requires adoption of disaster resilience frameworks and resilient health systems to ensure continuity of care. Health system strengthening and medical preparedness are key for mitigating the effects of disasters, especially in lower and middle-income countries (LMIC). A culture of disaster and medical preparedness along with health system strengthening as promoted in India provides the opportunity to protect populations from future disasters.

Key words: Health Security,Disaster Preparedness, Health Emergency Preparedness and Response, Disaster Medicine, Mass Casualty Management Plans

1. INTRODUCTION

Disasters**,** whether natural or man-made, pose a major challenge to human health and development. Their impact on the health of individuals and communities is often severe and can hinder attainment of global, regional, and national development goals. Natural, biological, technological and societal hazards put the health of vulnerable populations at risk and have the potential to cause significant harm to public health. Examples of these hazards are:

(1) Natural: earthquakes, landslides, tsunamis, cyclones, floods or

droughts. Biological: epidemic diseases, infestations of pests; and

(2) Technological: chemical substances, radiological agents, transport crashes. Societal: conflicts, stampedes, acts of terrorism.

Disasters, emergencies, and other crises may cause ill-health directly or through the disruption of health systems, facilities and services, leaving many without access to health care in times of emergency. They also affect basic infrastructure such as water supplies and safe shelters which are essential for health. International consensus views disasters as barriers to progress on the health-related Millennium Development Goals (MDGs), as they often set back hard-earned development gains in health and other sectors.

Disaster management (DM) for health is "EVERYBODY'S BUSINESS." The overview places DM in the context of multi-sectoral action and focuses on the generic elements of, including potential hazards, vulnerabilities of a population, and capacities, which apply across the various health domains. But, during the last few decades, biological emergencies have assumed an increasing importance, *e.g.,* major outbreaks related to new and re-emerging infectious diseases, such as SARS, influenza (H1N1 and H5N1), cholera, Ebola and present pandemic of Covid 19.

Major emergencies, crises and disasters have become more frequent during recent decades, especially in middle and low-income countries. They affect more and more people, disrupting health sector programs and essential services, and slowing the process of sustainable human development. Many lives could be saved if the affected communities were better prepared, with an organized and scalable response system already in place. In addition, survivors of mass casualty incidents often suffer disabilities or health impairment – physical or psychological. These can severely strain the health sector and draw scarce resources away from other essential programs. Again, much of this is avoidable. Experience shows that the community is the first to provide emergency assistance in such incidents. For this reason, preparedness planning increasingly emphasizes building capacity (human, organizational and infrastructural) at the community level. Empowering communities to develop emergency management plans for mass casualty incidents requires strong involvement by health authorities at all levels, especially the national, state and district levels, as well as support from other sectors.

2. GAPS IN DM RELATED TO HEALTH

Generally, the common gaps in health system preparedness around the world are well understood, but they are often not addressed in a comprehensive and systematic way. In particular, many countries have not yet developed Mass Casualty Management Plans, and communities are too often left alone to develop preparedness and response plans without guidance from higher levels. The development of an emergency plan should take into account existing as well as any plans developed for specific hazards. The pre-requisites for planning are:

(1) Recognition that risks and vulnerability exist, and that emergencies can occur;

(2) Awareness by the community, government**s**, and decision-makers of the need to plan and of the benefits of planning, implementation of the plan is guaranteed by appropriate legislation; and

(3) Designation of an organization responsible for coordinating both planning and emergency response and recovery in the event of an emergency.

The Disaster Management Act, 2005, 0f India was envisaged taking into account the vulnerability and hazards of India and paradigm shift in approach from relief-centric to that focused on preparedness, mitigation, response and recovery.

A wide range of incidents (both natural and man-made) are likely. Mass casualty incidents can take a variety of forms. Transportation systems (road traffic, aircraft, shipping, railroads) account for many such incidents, as do accidents in industries (chemical spills, factory fires) and buildings collapses. Outbreaks of disease can quickly outstrip the ability of local health care facilities to contain and treat them, as in the case of present pandemic. Most vivid in the public imagination are natural disasters – events of such a scale that endanger both populations and environments, *e.g.,* floods, cyclones, and earthquakes. The challenges that each of these disasters are not rehearsed adequately in the country, with scenario development exercises at all levels – national, state, district and local community levels.

3. MITIGATING HEALTH RISKS IN DM

The health risks of a disaster can be mitigated by decreasing exposures and the human susceptibility to the hazard, and building resilience of individuals, communities and the country to protect health, respond and recover effectively from the impact of the hazard. The issues involved include:

(a) *Human Issues* – mass casualty management; mental health and psychosocial support; nutrition; maternal reproductive and child health; and trauma care;

(b) *Facilities* – Availability of clean water, sanitation and hygiene; safer and prepared hospitals; health facilities; infrastructure and coordination between organizations; and

(c) *Preparedness* – Information, education and communication networks to promote healthy behavior in communities at risk of disasters.

Key considerations for DRM for health require:

(1) Developing health emergency and DRM systems at national, state, district and community levels;

(2) Emphasising on primary prevention, vulnerability reduction and strengthening community, provision of health facility, and embedding health system resilience by reinforcing a community-centred primary health care approach;

(3) Stimulating the development of further evidence-based technical guidance and training programs for the advancement of health emergency and DRM capacities, including priority technical areas; and

(4) Strengthening partnerships, institutional capacities and coordination mechanisms among health and related sectors for at national, state, district level.

3.1 Health Emergency and DRM Systems

Ministries at the central and state level agencies and other organizations have roles to play in emergencies, with the Ministry of Health (MoH) Government of India (GoI) taking on the central one, being the nodal Ministry. Although the names and responsibilities vary from country to country, these are likely to include (a) the Ministries and Offices of the home, agriculture, water resources Communications, and Environment, and (b) the various branches of the armed forces, Civil Defense agencies; Red Cross/ the private sector. Given the mix of roles and responsibilities, some form of a coordinating health structure should be in place similar to the NDMA, SDMA**s** and DDMA**s**. This structure should have formal roles laid out in the national emergency management plans and policies.

Also, many countries have a permanently staffed National Emergency Management Agency (or similarly named system), which assumes command, control and coordination responsibilities when large-scale disasters or emergencies occur. No matter what forms that government and public administration take, national emergency management systems should include:

(a) Identification of lines of authority, from the national to the local level;

(b) Financial arrangements for funding emergency work;

(c) Arrangements to ensure that government and community activities are maintained (*e.g.,* creation of parallel or "hardened" communications systems to take over, if normal voice or data transfer systems are affected);

(d) National stockpiling of appropriate resources (including state, district and local pre-positioning of stockpiles);

(e) Database of national experts for advice on specific problems; and

(f) Protocols and formal arrangements for coordinated efforts with other states and agencies, or between provincial/state governments within the country.

Increasingly, governments are adopting decentralized models of emergency management, devolving operational authority to the lowest possible level of government, recognizing that even though many emergencies can be handled effectively at local level, national political interest may require national involvement. But, some response capabilities may be maintained under national control. These may include Search and Rescue (SAR) teams and specialized functions, such as Hazardous Material ("Hazmat") units needed to deal with events such as chemical incidents or terrorist attacks. India has NDRF, which works under the control of Ministry of Home and provides a generic outline of how systems of emergency response are structured. NDMA Guidelines show lines of authority and a range of participating services or agencies.

Whatever the formal institutional arrangements, the Ministry of Health as nodal ministry for health emergencies should be heavily involved in all national emergency medical management potentially dealing with mass casualties, because of both its expertise and its normative role in the setting of health-related standards and rules and procedures. Because of its expertise, the Ministry of Health should be well placed usually to help health care facilities and main health disciplines to develop their emergency plans, create training programs, preparing drills and exercises, and so on. Finally, the Ministry of Health and the Departments of Health at the State and District levels are responsible for promoting standards and overseeing accreditation, for example in validating the plans developed by health care facilities and their local partners.

3.2 Dedicated Medical Unit at all levels for Medical Emergencies

A dedicated medical unit is required within the Emergency Medical Relief Division of the Office of the Director General of Health Services, MoH, GoI . Similar dedicated medical units should be constituted at the state and district levels also. These dedicated units should organize themselves in a way that maximizes the comparative advantages and brings together the people best suited to the task at hand. A necessary first step will be to create permanent systems with institutional responsibility for all Ministry of Health activities related to planning and managing mass casualty management events. In this regard, two aspects are crucial, namely: (a) the Emergency Operation Centers at the national, state and district levels will play a crucial role at the time of disasters; they need to be equipped and used for rehearsals in peace time; and (b) The District Disaster Management Authority (DDMA) at the local level should advice the decision makers on:

(1) Measures that will be helpful for the emergency planning and preparedness,

(2) Health actions to be taken in crises,

(3) Capacities to be built for trauma care,

(4) Management Systems Strategies needed for managing efficiently the emergencies, and

(5) Guidelines for building capacity of the health sector at all levels.

The said dedicated units should build formal and informal relationships with other partners. And, when a mass casualty incident occurs that requires immediate response and if emergency plans pre-exist, the relations can be invoked according to established procedures. Within such arrangements, the immediate role of the Department of Health at national, state and district levels will be to act as a focal point for liaison, coordination and communication between the various health system components, *e.g.,* public, private, army, ESI, Railways, NGOs and other such agencies. This should be done based on health sector plans that take into consideration the need for interdisciplinary coordination with health partners. Because of the potential for confusion arising over systemic issues (such as legal authority, jurisdiction, and customs' import procedures), the Ministry should sign Memoranda of Understanding (or equivalent agreements) with other partners to formalize the necessary pre-arrangements. These agreements should be written with relevant national legislations in mind. Equally important is that the MoH staff should establish working relationships with staff in other organizations, so that, during a crisis, the "players" (key individuals) are known to each other. This can be most effectively done by joint planning and exercises at all levels), as well as regular meetings and periodic evaluations or reviews.

4. RESILIENT HEALTH SYSTEM

A Resilient Health System (RHS) is one, which is able effectively to prepare for, withstand the stress of, and respond to the public health consequences of disasters. RHSs are able to protect themselves and human lives from the public health impact of disasters and are critical to achieving good health outcomes before, during and after disasters. RHSs should be aware of the strengths and vulnerability of its building blocks and the spectrum of hazards and risks to which it is exposed. They should be able to respond to a wide range of public health issues before or during a disaster. Health systems should be able to quickly and effectively adapt to changing situations and should use integrated approaches for responding to public health events, such as disasters. Lastly, a RHS should be able to regulate itself. These elements provide a good basis for strengthening and using health system for public health disaster risk management.

The recent biological disaster Covid-19 aptly illustrated the complex interaction between health systems and disasters. A vicious cycle in which weak health systems provide fertile grounds for the deterioration of public health and hazards into disasters which further decimate already weak health systems. Also, the sustained transmission of the Ebola virus disease outbreak during 2014/15 in Guinea, Liberia, and Sierra Leone was linked consistently to the weak health systems in these countries. The outbreak resulted in the death of several health workers depletion of scarce financial resources, and diversion of medical equipment. This, in addition to overburdening of already weak health information and supply chain management systems, also resulted in disruption of health services delivery in these countries. Other disasters, such as the Yellow Fever outbreaks in Angola, Democratic Republic of Congo and Uganda, and ongoing armed conflicts in South Sudan, Central Africa Republic, northeast Nigeria, and other African countries, also had similar consequences.

This pattern is not limited to Africa. The fragile pre-disaster health systems in the city of New Orleans in America and the Eastern Visayas Region of the Philippines contributed to the public health consequences of Hurricane Katrina and Haiyan, and constrained timely and effective post-disaster health system recovery efforts. The pre-Katrina health system in the city of New Orleans was characterized by low coverage of health insurance and reduced access to health services by the largely poor population of the city. Similar challenges (such as inadequate health-care infrastructure, staffing, and low coverage of health insurance), which reduced access to health services, also were prevalent in the affected areas of the Philippines pre-Hurricane Haiyan.

On the contrary, a RHS could reduce vulnerability to the public health consequences of disasters. In the aftermath of a disaster, strong supply chain systems for essential medicines, safe health facilities, and adequate numbers of well-trained health workers would ensure the provision of uninterrupted basic health-care services to disaster affected populations. A functional health information management systems would provide the information required for timely detection and response to presence of biological hazards (such as cholera, typhoid fever, diarrhea, measles, influenza and encephalitis), which often occur in the aftermath of disasters. Adequate financing of emergency health service programs, and strong health governance and oversight systems would ensure that human, financial, and logistics resources are available and utilized to implement well-coordinated DRM strategies to mitigate the public health consequences of the disaster. Good service delivery and coverage of key public health interventions (such as immunization, insecticide-treated bed nets, clean water, and improved sanitation, health education, like the use of mask and social distancing during Covid 19 situation) would prevent disease outbreaks among disaster-affected populations. These would contribute to good public health outcomes during a disaster.

In practical terms, effective measures to address the public health consequences of droughts, such as good immunization coverage, adequate nutrition, and health services delivery including clinical management of severe acute malnutrition, ongoing surveillance of nutrition indicators, and effective risk communication about malnutrition, would ensure that such situations do not deteriorate into famines. Similarly, safe and well-sited health facilities, good health sector disaster mitigation, contingency and business continuity planning, adequate essential medicines and needed supplies for trauma care, and well-trained health staff would ensure that the consequences of earthquakes do not result in major public health disasters.

Therefore, practical application of RHSs as a framework for strengthening public health DRM is an imperative in India. This requires the strengthening and use of the six health system building blocks, namely: (1) health service delivery, (2) health workforce, (3) health information management system, (4) medical products including vaccines and technologies, (5) health financing, and (6) health leadership and governance, as elements in the implementation of public health disaster risk reduction (DRR), preparedness, response and post-disaster recovery interventions at the individual, community, and formal health sector levels. Apart from weak health systems, poor status of the social determinants (such as poverty, lack of good housing, and inadequate access to good nutrition), clean water, improved sanitation, education, and social protection **can** reduce individual and community resilience and increase the risk of disasters.

The Sendai Framework for Disaster Risk Reduction (SFDRR) and sustainable development goals (SDGs), both of which are landmark United Nations agreements adopted in 2015, recommend scaling up implementation of DRR strategies as means to improve resilience to disasters globally. The SFDRR, in contrast to its predecessor (the Hyogo Framework for Action), puts a lot of emphasis on health. It proposes RHS as an opportunity for ensuring effective DRR in the health sector. The World Health Assembly, through resolution 64.10, urged countries to strengthen DM programs by incorporating them into national health systems. Also, it has been noticed that parallel implementation of health systems strengthening and public health DM programs within Ministries and Departments of Health and between their DM counterparts result in duplication of efforts and lack of synergy.

4.1 Resilient Built Environment related to Health Systems

Structurally reinforced hospitals reduce vulnerability to disasters. Resilience is a program focusing on advocating a planned preparation in strengthening hospitals and health care institutions, to respond effectively during disasters as well as fast recovery from the impact of extreme events. Hospital management and its built environment (representing building and infrastructure systems within a defined boundary) should perform in a predictable manner during and after a hazard event and/or disaster. The failure of hospitals to absorb and accommodate pressures during disasters will cause performance degradation of services and healthcare of the hospital and health department. Such a strategic approach should be taken to increase the level of resilience of the health infrastructure, with focus on the criteria of robustness, redundancy and rapidity. An initiative to investigate the robustness of the existing health infrastructure by examining compliance of these buildings and facilities to prevalent building safety codes and NDMA Guidelines on Hospital Safety, will go a long way in correcting shortcomings in the structure, architecture, planning, zoning and redundancy. It will help upgrade planning and operations, and build rapidity in communication, movement and thereby risk assessment.

Further, a similar effort is required to ensure that all new Hospital and Medical infrastructure being added in the country is disaster resilient. The new hospitals are built with a sufficient level of protection (and existing healthcare infrastructure strengthened to such levels of protection) that they remain functional and deliver health services in emergency situations. Protection of other vital infrastructure, and facilities that have the potential to generate risks to public health, such as water and sanitation systems and chemical facilities, should also apply risk management measures. Adherence to building standards and retrofitting of vulnerable health infrastructure, protection of ecosystems, and ensuring effective insurance regimes and microfinance initiatives to ensure business continuity across all healthcare setting. Disaster preparedness, including response planning, training, pre-positioning of health supplies, development of surge capacity, and exercises for healthcare professionals and other emergency service personnel, is critical for the effective performance of the health sector in the response.

4.2 Resilience through Proactive Community Readiness

Disasters and other emergencies often impact significantly people's health, including the loss of many lives. Every new threat reveals the challenges for managing health risks and effects of emergencies and disasters. Deaths, injuries, diseases, disabilities, psychosocial problems and other health impacts can be avoided or reduced by disaster risk management measures involving health and other sectors. DRM for health is a multi-sectoral effort, and refers to the systematic analysis and management of health risks, posed by emergencies and disasters, through a combination of: (i) hazard and vulnerability reduction to prevent and mitigate risks, (ii) preparedness, (ii) response, and (iv) recovery measures. The traditional focus of the health sector has been on response to emergencies. The ongoing challenge is to broaden the focus of DM for health from that of response and recovery to a more proactive approach, which emphasizes prevention and mitigation, and the development of community and country capacities to provide timely and effective response and recovery. RHSs based on primary healthcare at community level can reduce underlying vulnerability, protect health facilities and services, and scale-up the response to meet the wide-ranging health needs in disasters.

Healthcare systems provide core capacities for DRM for health. Some countries affected by disasters have limited basic health services and infrastructure, which in itself hugely compounds the challenges of disaster response. Often, countries with well-developed systems are much more resilient and better prepared to face disasters. Primary Health Care centers (PHC)s focus on basic services to improve health status which, in turn, builds community resilience and provides the foundation for responding to emergencies. Many lives can be saved in the first hours after an emergency through community response before external help arrives. Hospitals and health infrastructure health systems are composed of public, private and nongovernmental facilities, which should work together to serve the community; these include hospitals, PHCs, laboratories, pharmacies and blood banks.

4.3 Surge Capacity

Safe hospitals programs ensure health facilities are built to withstand hazards safely, remain operational in emergencies, and have adaptable and resilient healthcare systems. Healthcare systems need to prepare to cope with large numbers of patients during the disasters. This may require mobilizing medical staff to aid affected areas. Plans to maintain the continuity of health sector operations include identifying priority services, having mechanisms for response coordination and communicating with staff and partner organizations. Multi-sectoral action for the health of the population to be protected during and after a disaster, and wider determinants of health (such as water, sanitation, nutrition and security) also need to be adequately addressed through multi-sectoral action. Essential infrastructure (such as communications, logistics, energy and water supplies) and emergency services and blood banking facilities need to be protected through multi-sectoral action to ensure the continuity of health services.

4.4 Education

It is essential to to build a culture of health, safety and resilience at all levels through education, training and technical guidance, strengthening the knowledge, skills and attitudes of professionals in health and other sectors for managing the health risks of disasters. Similarly, information, education and risk communication are important for households and communities at risk to promote healthy behavior to reduce risks and prepare for disasters. This may be through raising awareness through the media and community-based disaster risk management programs.

A public health priority for those with a low socioeconomic status, could be: (i) Older than 65 years, (ii) Younger than five years,

(iii) Females, (iv) Persons with chronic illness, (v) Persons with disabilities, and (vi) Victims of social isolation or exclusion. This mass media education should happen proactively.

5. CLOSING COMMENTS

In the context of DM, public health programs build capacities and resilience of individuals and communities to risks, to reduce the impact, cope with and to recover from the effects of adversity. The objective of preparedness of health services for disasters and emergencies should focus on: (a) preventing morbidity and mortality, (b) providing care for the injured, (c) preventing and controlling outbreaks and epidemics, (d) restoring health services, (e) protecting the health workforce, frontline workers and responders, besides maintaining public health and medical resources required for delivery of services during emergencies. In this regard, the following are important for DM to succeed:

(1) Commit sufficient resources to support DM for health;

(2) Assess risks to health and health systems;

(3) Identify risk mitigation measures based on risk assessments;

(4) Implement risk mitigation measures through detailed planning of money, manpower and technology; and

(5) Monitor (including through surveillance) of potential threats to health, particularly from biological, natural and technological (such as chemical and radiological hazards) sources, to enable early detection and warning to prompt action by the public, health workers and other sectors.

References

1. Aitsi-Selmi,A., Egawa,S., Sasaki,H., Wannous,C., and Murray,V., (2015), "The Sendai framework for disaster risk reduction: renewing the global commitment to people's resilience, health, and well-being," **International J. Disaster Risk Sci.**, 6(2), 164–176,

http://doi.org/10.1007/s13753-015-0050-9.

2. HAMER, (2014), "Health Management in Emergency and Disaster Situations," Hacettepe University Press, Ankara, pp 16–25

3. Ardalan,A., Ordun,C.Y., and Riley,J.M., (2015), "Public health and disasters, second ed. Ciottone's Disaster Medicine. Elsevier, Philadelphia, http://doi.

4. Boyd,A., Chambers,N., French,S., Shaw,D., King,R., and Whitehead,A., (2014), "Emergency planning and management in health care: priority research topics," Health Syst. (Basingstoke, England) 3(2), 83–92, http://doi.org/10.1057/hs.2013.15

5. Ciottone,G.R., (2015), "Introduction to disaster medicine," *Ciottone's Disaster Medicine*, Second Ed.. Elsevier, Philadelphia, USA

6. Dar,O., Buckley, E.J., Rokadiya,S., Huda,Q., and Abrahams,J., (2014), "Integrating health into disaster risk reduction strategies: key considerations for success," **Am. J. Public Health**, 104 (10), 1811–1816

7. Hall,M.L., Lee,A.C.K., Cartwright,C., Marahatta,S., Karki,J., and Simkhada,P., (2017), "The 2015 Nepal earthquake disaster: lessons learned one year on," **Public Health,** 145, 39–44

8. Hogan,D.E., and Burstein,J.L., (Eds.), (2010), "General concepts: basic perspectives on disasters," *Disaster Medicine*, Second Edition, Wolters Kluwer & Lippincott Williams & Wilkins, Philadelphia, PA, p 10

9. Hou,S., Lv,Q., Ding,H., Zhang,Y., Yu,B., Liu,Z., Su,B., Liu,J., Yu,M., Sun,Z., and Fan,H., (2016), "Disaster medicine in China: present and future," **Disast. Med. Public Health Prep.,** 1–9, http://doi.org/10.1017/dmp.2016.71.

10. Hubloue,I., and Debacker,M., (2010), "Education and research in disaster medicine and management: inextricably bound up with each other," **Eur. J. Emerg. Med.,** 17 (3), 129–130

11. James,J.J., Benjamin,G.C., Burkle,F.M., Gebbie,K.M., Kelen,G., and Subbarao,I., (2010), "Disaster medicine and public health preparedness: a discipline for all health professionals," Disast. Med. Public Health Prep., 4(2), 102–107

12. Leaning,J., and Guha-Sapir,D., (2013), "Natural disasters, armed conflict and public health," **N. Engl. J. Med.** 369 (19), 1836–1841, http://doi.org/10.1056/NEJMra1109877

13. Bogucki,S., and DeAtley,C., (2018), "The Role of Hospital Medicine in Emergency Preparedness: A Framework for Hospitalist Leadership in Disaster Preparedness, Response, and Recovery," ***J. Hosp. Med*.,** October2018, 13(10):713-718 | 10.12788/jhm.3073

14. Persoff,J., Ornoff,D., and Little,C., (2015), "Mass casualty disasters: who should run the show?," **J Emerg Med.**, 48(6):685-92. doi: 10.1016/j.jemermed.2014.12.069; ePub 30 March 2015

15. Gershon,R.R., Vandelinde,N, Magda,L.A., Pearson,J.M., Werner,A., and Prezant,D., (2009), "Evaluation of a pandemicc preparedness training intervention for emergency medical services personnel,' **Pre-hosp Disaster Med.**, 24:508–11

16. Rifino,J.J., and Mahon,S.E., (2016), "Role of Emergency Medical Services in Disaster Management and Preparedness," *Ciottone's Disaster Medicine*, Second Edition, Elsevier, Philadelphia, Chapter 3. http://doi.org/10.1016/B978-0-323-28665-7.00003-0

17. Stehrenberger,C.S., and Goltermann,S., (2014), "Disaster medicine: genealogy of a concept," **Soc. Sci. Med.**, 120, 317–324, http://doi.org/10.1016/j.socs-cimed.2014.05.017

18. Stratton,S.J., (2014), "Is there a scientific basis for disaster health and medicine?" **Prehospital Disast. Med.**, 29 (3), 221–222, http://doi.org/10.1017/S1049023X14000582

19. Suner,S., (2015), "History of disaster medicine," **Turk. J. Emerg. Med.**, 15 (Suppl 1), 1–4, http://doi.org/10.5505/1304.7361.2015.69376

20. UN, (2009), "Hospitals Safe from Disasters—Reduce Risk, Protect Health Facilities, Save Lives," 23 November 2020

21. UNISDR, (2015a), "Sendai Framework for Disaster Risk Reduction 2015–2030," Kobe, Hyogo, Japan, 23 November 2020

22. UNISDR, (2015b), "Sendai framework for disaster risk reduction 2015–2030," Third World Conference on Disaster Risk Reduction, Sendai, Japan, 14–18 March 2015, 23 November 2020

23. WADEM, (2017), "Association overview," https://wadem.org/about/association-overview/

    Accessed on 23 November 2020

24. Wang,Z.G., Zhang,L., and Zhao,W.J., (2015), "Emergency medicine for disaster rescue," **Chin. J. Traumatol**., English Edition, 18 (6), 311–313, http://doi.org/10.1016/j.cjtee.2015.12.004

25. UN, (2014)< Health and Disaster Risk Reduction

    http://www.wcdrr.org/uploads/HEALTH.pdf

    Accessed on 23 November 2020

26. WHO, (2007), "Risk reduction and emergency preparedness: WHO six-year strategy for the health sector and community capacity development," Geneva, Switzerland

    http://www.who.int/hac/techguidance/preparedness/emergency_preparedness_eng.pdf

    Accessed on 23 November 2020

J. R. Bharadwaj

Safety in Chemical, Gas and Petroleum Industries

Abstract: Chemical, Gas and Petroleum Industrial Sector in India are potential source of accidents and disasters. In spite of strong legal and institutional framework, still there appears to be lack of coordination amongst various agencies and authorities resulting in minor to major accidents. Proper hazard identification, risk assessment and defining the strategies for adoption disaster risk reduction measures are keys for developing a safety culture in chemical industries. Developing proper Standard Operating Procedures and leadership at all levels amongst the workers are needed urgently. An ethically-driven management system is important in developing strong safety culture in the chemical, gas and petroleum industries.

Key words: Industrial safety, Legal and institutional Framework, Hazard Identification, Risk Assessment, Disaster Risk Reduction

1. INTRODUCTION

Chemical Industries in India are very heterogeneous group and consist of chemical and gas and petroleum sectors. The chemical sector comprises organic, inorganic, pesticides, fertilizers, dyes and paints and many more industries using highly toxic to toxic chemicals. In addition, during the process of operations many chemicals produce biproducts which are even more toxic than the basic compounds. India's chemical industry ranks as the third largest in Asia. There are also a large number of MSME and small scales chemical industries in addition to more than two thousand Major

Accidents Hazardous (MAH) units. They are all potential sources of accidents and disasters.

The Methyl-isocyanate Chemical leak in Bhopal in December 1984 drew the attention of the authorities which focused on the unprecedented potential of HAZCHEM in the term of loss of life, short- and long-term harmful effects on loss of life and damage to the environment. This resulted in strengthening the institutional and legal framework mechanism for the management of chemical accidents and disasters in India. In spite of much advancement, a large number of minors to major accidents occur every year. Therefore, it is imperative to go on looking for safe operations while using the modern technological advances and innovations [Bhuyle, 2016; NDMA, 2007].

2. LEGAL AND INSTITUTIONAL FRAMEWORK

Safety Operations remain the core issue in the effort to prevent accidents and save lives and property, in the functioning of chemical industries. For safety operations and their implementation, a large number of acts, rules and regulations were enacted post Bhopal Disaster by the nodal Ministry of Environment, Forests and Climate Change, and other line Ministries. The first Factories act was enacted in 1881 which mainly focused on workers safety. Since then, major focused was laid on prevention on major accidents to protect communities and environment by improving safety processes. Manufacture, Storage and Import of Hazardous Chemical (MSIHC) rules were enacted in 1989 followed by Chemical Accidents, Emergency Planning, Preparedness and Response (CEAPPR) rules in 1996, which are in line which international best practices adopted by consultative process under the UNEP Awareness and Preparedness for Emergencies at Local Level (APELL) project.

2.1 Important Legal Provisions

Acts and Rules comprise the legal provisions applicable for industrial safety (**Table 1)**. But, from the point of view of Disaster

Management (DM), mainly three documents (*i.e.,* MSIHC Rules, 1989, CEAPPR and Disaster Management Act, 2005) work together in a participatory manner for planning, prevention and preparedness to achieve desired level of safety operations.

Table 1: List of Important Legal Provisions related to Safety of Industries

S. No.	Acts	S. No.	Rules
1	Factory Act, 1948, as amended in 1976 and 1987	1	State Factory Rules under Factory Act, 1948
2	Environment (Protection) Act, 1986	2	MSIHC Rules, 1989, as amended in 1992
3	Disaster Management Act, 2005	3	CEAPPR Rules, 1996
4	Public Liability Insurance Act, 1991, as amended in 1992	4	Explosives Rules, 2008
5	National Environment Tribunal Act, 1995	5	Central Motor Vehicles Rules, 1989
6	The Explosive Rules, 2008	6	Hazardous Wastes (Management Handling) and transboundary movement rules 2008
7	Petroleum Act, 1934	7	Trans-boundary Movement Rules, 2008
8	Electricity Act, 2003		
9	Dock Workers (Safety, Health & Welfare) Act, 1986		

2.2 Existing Institutional Framework

The Working Framework as it exists on **the** ground is presented in **Table 2**. There is a significant overlap in above to arrangements, and proper synchronization is required in the two mechanisms for a smooth functioning at District Level [Bhuyle, 2016; NDMA, 2007].

Table 2: Key Existing Institutional Framework related to DM in Industries

S. No.	MSIHC & CEAPPR Rules	DM Act, 2005
1	Organizational Structure for Planning, Prevention, Mitigation, Preparedness and Response as per CEAPPR Rules consist of State Crisis Group (SCG), District Crisis Group (DCG) and Local Crisis Group (LCG)	Under the National and State DM Acts, the NDMA, SDMA and DDMA are established at National, State and District Level, respectively
2	These group consists of members from line Departments and Public Response Agencies, *i.e.,* Fire, Police, Medical, Technical Experts and Industry Members	These groups include line departments (Fire, Police, and Medical at State and District levels), in addition to local Administration, Experts and Community Members.

3. HAZARD IDENTIFICATION

Safety in the **c**hemical **i**ndustry is the practice of handling chemical in **a** safe manner, minimizing the **h**azard to Community and Personal Health. It is very important to identify the Hazards caused by the chemicals being used in the industry. Hazard Identification is the first step in any workplace for risk assessment. Hazard is the source with a potential to harm to human life, damage to property, damage to environment or both. Following are the broad categories of hazards in a Chemical Industry. They are: (1) Mechanical, (2) Electrical, (3) Radiation, (4) Substances, (5) Fire & Explosion, (6) Toxic Release, and (7) Effect of Natural Calamities. A particular Industry should identify and assess potential hazards that can exist on the workplace and institute control measures to ensure safety. Now, there are experts, who can assess the hazards prevalent in a industry, which can cause harm to the what extend so that the work managers can place control measures in place [Brock and Pendegrass, 1986].

4. EFFECTIVE CONTROL MEASURES

Hazard reduction can be achieved through various actions taken particular industry in keeping view the type of chemical being used and other Control Measures, like:

(a) Elimination of the hazard at the initial stage by procuring the best machinery keeping safety being the sole criteria;

(b) Substitution of more toxic substances by less toxic agents. Such chemicals have to be selected, which has physical and chemical properties to be more heat stable, less polluting and easily replaceable;

(c) Engineering Controls, like providing enclosures, providing proper ventilation and isolation from the workforce;

(d) Administrative measures like providing proper personal protective equipment (PPE), shorter tenure of duties, holding frequent mock exercise and ensuring nutritious foods to the workers specially industries dealing with paints and dyes;

(e) Various methods of hazard identification are checklist, safety audit, hazard indices and preliminary hazard analysis; and

(f) Hazard and Operability (HAZOP) Study can be undertaken to identify in a process plant and operability problems, which could compromise the plants ability to achieve design intent.

5. RISK ANALYSIS

Risk is the measure of potential loss or human injury in the term of probability of loss or injury and its magnitude. Many people consider hazard analysis and risk assessment is same exercise, but it is not true. Risk can be defined as:

Risk = Hazard × Venerability

The Code of Practice laid down by the Bureau of Indian Standards IS 15656: 2006 is a critical input here for hazard analysis and risk assessment [IS 15656, 2006]; the flow chart for risk analysis is given in **Figure 1**.

5.1 Methods Used for Risk Assessment

Methods for the risk assessment (Figure 1) of priority assessment chemical substances are systemization of various individual methods, such as mathematical or computer model and requires information of chemicals, manufacturing, hazard information and various details of their Hazchem handling. Assessment is done to determine whether there exists a risk of damage to human health or population and/or animals and plants in the living environment due to environment contamination attribute to the chemical substances. First step for risk assessment will be collection of relevant data on chemical being handled, quantity of chemical stored, the chemical reaction (micro thermal analysis), hazard assessment related to other existing physical and environmental conditions on the workplace. Most common method used for risk assessment is done by considering two components, Severity and Probability. Severity is related to chemical domain considering quantities of chemical and its adiabatic temperature rise potential, destructive power from pressure increase resulting into vaporization. Secondary effects, like release of explosive or toxic compounds, can enhance significant degree of severity.

Probabilities of runway reactions are difficult to evaluate. They depend upon various triggering factors. A runway reaction within short time is much more damaging than that spread over longer period of time. Steps involved in risk assessment include proper planning, hazard identification, dose-response assessment, exposure assessment and risk characterization [GIDM, 2020; IS 15656, 2006].

5.2 Disaster Risk Reduction Strategies

International frameworks, to which India is signatory is Sendai framework for disaster risk reduction (2015-30), serves as blueprint for multi-hazard disaster risk reduction. It has a wider scope than earlier Hyogo Framework. One has to focus more in detail for DRR for chemical industries. Basic approach should aim at:

(1) Reducing exposure to hazards;

(2) Lessening the vulnerability of people and property;

(3) Wise management of land and the environment; and

(4) Improving the preparedness for effects of an accident or disaster.

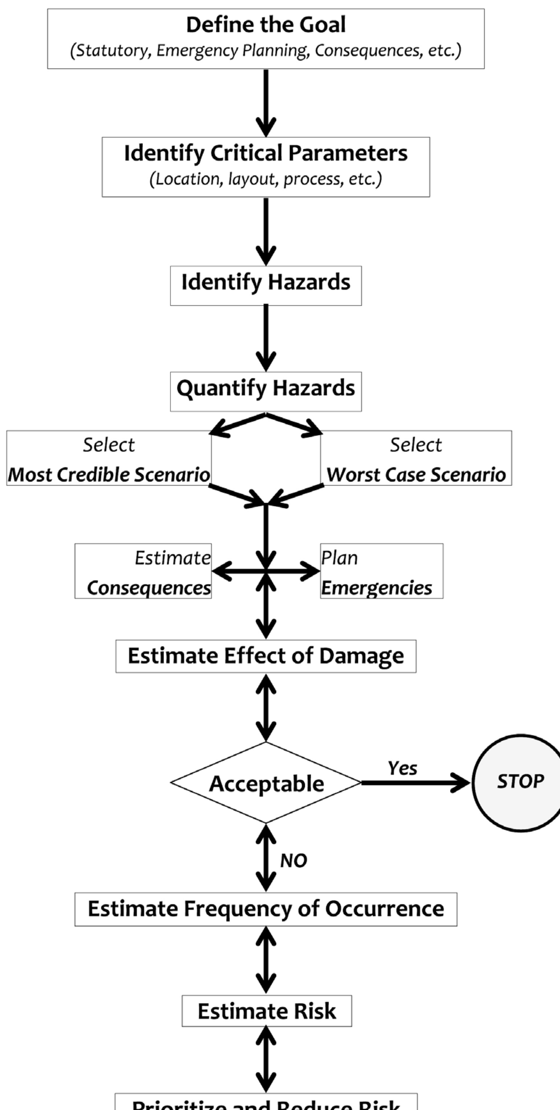

Figure 1: Flow chart for Risk Assessment as per Indian Standard [IS 15656, 2006]

DRR is interconnected closely with sustainable development as per Goal 9 (industry, innovation and infrastructure) of the Sendai Framework. A hierarchical approach to DRR should be designed to: (a) Eliminate and minimize hazards by safer design, (b) prevent to the extent possible, (c) Early stage detection and create early warning system, (d) Control to limit the scale, intensity and duration of disaster; (e) Mitigate consequences; and (f) sound emergency response plans.

In addition to DRR plan, DRR should focus not only on emergency response plan, but also on recovery, rehabilitation and reconstruction. In 1986, after Bhopal Disaster, occupational safety and health administration (OSHA) developed guidelines for the industry workers in reducing potential hazards in chemical industries. They focus on disaster prevention and plant management. Every chemical industrial unit is required to develop such guidelines for their plant [Brock and Pendegrass, 1986; IS15656, 2006; Park, 2011; SPR, 2016].

5.3 Risk Management Strategies

Risk Management Strategies are based on risk identification, risk analysis, risk control, risk financing and claims management. Risk identification has to be gauzed in term of damage to life, property and environment. Financial loss so caused has to be covered by proper liability insurance scheme. Risk analysis, of course, has to be done based on severity and probabilities. Risk control aims at risk avoidance, risk prevention and risk reduction. Most difficult exercise remains the risk financing and can be managed through insurance. Claims Management to recover the loss will depend on many factors like type of insurance, life of the machinery and human errors. Health care risk management itself remains a big issue and should be incorporated into risk management at all stages.

6. SAFETY – THE ULTIMATE GOAL

Key to achieve safety of operations at a chemical plant is based on good risk assessment and control. A sound scientific knowledge of possible hazard scenarios, chemical engineering and safety technologies goes long way for minimizing risk during operations. In addition, a sound managerial competence and commitment by the staff is essential. Every unit should design a safety program which should clearly spell out what needs to be done by all the members of team. Basic fundamental knowledge of chemical process, safety in design, construction and operation of their plants is highly disabled. Safety is just not an action but is implementing behavior-based safety culture and is more than having procedures and measuring results. It is the attitude, belief and values that workers share at workplace. This culture needs to be developed on following effective core values:

(1) Leadership – Leaders at all levels should set individual examples;

(2) Responsibility - Every worker should share of responsibility;

(3) Accountability – Managers should be held accountable to lead by example and every day.

(4) Clear expectations - Safety expectations need to be set and communicated to everyone.

(5) Ethically driven management systems are important in developing strong safety culture.

The following old saying should not be forgotten:

"The superior man when resting in safety does not forget the danger may come...

When all is orderly, he does not forget that disorder may come."

Confucius (551 BC – 479 BC)

References

1. Bhuyle,V., (2016), "System Approach to Process Safety," Chemical Industry Digest, June 2016.

2. Brock,W.E., and Pendegrass,J.A., (1986), Safety and Health Guide for Chemical Industry Occupational Safety and Health Administration

(OSHA), Department of Labor, USA

3. GIDM, (2020), Personal Communication, Gujarat Institute of Disaster Management, September 2020.

4. *Hazard Identification and Control Measures in Chemical (Industrial) Workplace*, Capacity Development Program, Industrial Disaster Risk Management (IDRM), FICCI, Addition 1, 2010

5. IS 15656, (2006), Hazard Identification and RISK ANALYSIS, Code of Practice, Bureau of Indian Standards, New Delhi

6. NDMA, (2007), *National Disaster Management Guidelines – Chemical Disasters*, Government of India

7. Park,K., (2011), *Introduction to Safety in Chemical Process*, Cyber Lecture, 26 September 2011, Department of Chemical Engineering, Middle East Technical University

8. SPR, (2016), *Marine Structural Design*, 2nd Edition,

www.safetyproresources.com.

Accessed on 10th November 2020

Manu Gupta & Anshu Sharma

Urban Disaster Risk Reduction: Citizen Centred Approaches

Abstract: Historically, Disaster Management (DM) has been an issue concerned with the rural masses in India. In the new millennium, disasters have 'become' more urban, raising questions over awareness, understanding of the characteristics and the institutional set-up for urban risk governance. Recent urban disasters in India have also challenged traditional approaches to response. Current *official* risk management approaches need to evolve to be partnership-based, able to leverage technology and become increasingly de-centralized, thus addressing risk comprehensively. This paper builds on the authors' personal experiences in working with local citizen groups in addressing disaster risks across several cities in India.

Key words: Urban Risk Governance, Risk Management, Urban Resilience, Technology for Good, Local Leadership

1. INTRODUCTION

The current levels of risk in urban centres across India are largely a result of change that has taken place in the country in the latter half of the 20th century. In the span of 60 years, the number of urban centres grew from 3,060 to 7,933. In terms of absolute numbers, the urban population grew from 62 million to 377 million [CoI, 2011] - an increase of over 600%! With the years gone past since the last census, these numbers are already higher by now. Considering the strategic importance of urban centres to any developing economy, and the potential damage that can result on account of increasing risk, such an issue should get high importance. But, very little effort has really gone into reversing the trend. Small and medium disasters continue to recur, and a hugely indifferent urban community and the under-resourced, under-staffed local governments manage to address the problem in inadequate measure.

Over the years, because of a rapid shift from primary to secondary and tertiary sectors of economy, urban centres witnessed sudden spurts in their population. While change took place rapidly, the conventional planning process failed to accommodate the same with equal speed. In India, the town planning process has followed the standard routine of preparing comprehensive city development plans with 20-year perspectives. The responsibility of plan preparation rests with the town and country planning departments of states, or with city development authorities. The plan making process follows a linear routine of survey-analyse-plan. Procedures typically begin with extensive data collection, followed by lengthy data analysis. Options emerge, which undergo a thorough review involving respective local authorities and also include a process of inviting `objections' before the plan is prepared. It is a lengthy process, culminating in inflexible plans that often run into difficulty during implementation, because they assume institutional and administrative resources that are rarely available, and they see the community as a silent recipient of whatever is delivered to them instead of being active participants in dreaming and planning their city as per their aspirations. As Delhi's Master Plan drafted in 1962 (India's first Master Plan developed by the Town Planning Office set up for this purpose in 1955) has shown, urban growth has continued in the shadow of un-implementable Master Plans, leading to increasing trends of risks [TCPO, 2020].

Urban risks usually stem from local and micro-level problems that cumulate into big disasters. Encroachments on drainage channels and riverbeds in cities like Mumbai and Chennai have led to complete collapse of the cities in any event of heavy rains. Non-implementation of basic building bye-laws often causes buildings to collapse and infrastructure to fail. Perpetration of shanty structures has led to devastating fires in the past. If urban risks have to be reduced, their causes at the micro-level, the neighbourhood, have to be addressed. Local knowledge and wisdom have the potential to provide some solutions towards this. SEEDS [SEEDS, 2020a] has experimented with the Community Action Planning (CAP) process [Hamdi, 2010] and has tested the same in various cities across India. The process has characteristics shared with the better-known PRA (Participatory Rapid Appraisal) techniques. It is problem-based and opportunity-driven; based on achievable actions; participatory; reliant on local knowledge and wisdom; non-reliant on complete information; small in scale; incremental rather than comprehensive and has visible, tangible objectives.

2. THE PROBLEM

The urban risk problem has been brewing for long under the radar. It erupted in a string of prominent disasters since the last two decades. Ahmedabad and four urban centres in Kutch took a hit in the 2001 Gujarat Earthquake, Mumbai went under water in a first instance of its scale and intensity in 2005 and Leh in the cold mountain desert saw unprecedented flash floods in 2010. This was followed by a string of flash floods, hitting Srinagar, Chennai, Bhopal, Hyderabad and other cities. Unprecedented urban disasters started becoming a common phenomenon. Besides floods and earthquakes, other disasters showing up include naturally triggered ones such as heat waves, cold waves and storms, and technological ones such as fires, air pollution, epidemics and accidents. The first set of problems we face in this regard is the changing and diversifying nature of the hazards themselves, made worse by climate change and current development patterns [TERI, 2015]. The second level of problems is how local governments are completely overrun during disasters and have little capacity even otherwise to invest in risk reduction. Capacity issues, including financial, human resource and technological dimensions, make it imperative for us to look at community centric and citizenry based solutions wherein we capitalise upon our largest resource, our people, and their most valuable attribute, the inherent sense of resilience that comes from generations of living with risk.

On the urban planning front, urban development management needs to improve its capacity to manage and recover from catastrophic failures, across almost all sectors in urban setting - transportation, infrastructure, waste disposal, and this can be done best when resilience systems are built into the design, construction and operations [Surjan *et al*, 2009]. Resilience in this regard would include the ability to anticipate, absorb and adapt to shocks and stresses.

At the design stage every city has its plans for expansion - being catchment areas, wetlands are particularly important in this regard. Much of the recent urban flooding phenomena (Srinagar, Chennai, Kochi) has been founded in developments that are in lands that were erstwhile natural catchments or natural wetlands.

Factoring social vulnerability assessments in planning processes can throw light on where the projections will go wrong, for example, low-income settlements that are usually located in low lying areas will have a physical, economic and social dimension to their vulnerability that should be an urban planners concern [UNDP, 2017]. Planning processes need to provide for high density areas with required safeguards.

Considering the fact that the bulk of India's building stock is non-engineered [Arya, 2000], and even the balance stock is not necessarily made to withstand earthquakes of expected magnitudes, the risk of earthquakes is acute and is particularly accentuated in urban areas. Given that India is rapidly urbanising, large scale migration has overloaded the limited housing stock in cities and more and more families are living in unsafe buildings on hazard prone land parcels. Every year, on an average there are more than three thousand incidents of building collapse in country. These are symptomatic of the current state of infrastructure and its vulnerability to earthquakes.

DM is able to achieve the most in such settings primarily with empowered local leadership and organised local action. The role of citizen groups, resident welfare associations, market trader associations, local interest groups, prominent local citizens and leaders, who have direct stakes in the area's survival, is the best channel to invest in for long term and deep rooted returns in terms of resilience building.

3. LOCAL LEADERSHIP AND DISASTER RISK MANAGEMENT

Disaster risks are growing more intense, complex, and unpredictable. Scientific research shows that climate change is exacerbating this trend and that we are living in the era of a 'new normal'. Over the last 20 years, some 90% of major recorded disaster events were weather-related [UN, 2015]. Urban flooding is already known to be becoming more frequent and widespread. Loss of human lives may be decreasing, but the economic impact, particularly in terms of impact on informal economies and uninsured losses, are on the rise. Disasters are negatively impacting the overall development of the most vulnerable communities.

This growing unpredictability and intensity of extreme events, in the midst of increasingly complex socio-economic dynamics fuelled by growing inequalities, call for a new approach to resilience building and planning. This is a challenge that cannot be addressed by formal institutions alone.

With a deep understanding of their contexts, local leaders are a vital cog in the wheel of resilience building [Gupta and Sharma, 2002]. They have a unique ability to reach excluded communities who lack access or fall outside the gambit of large-scale programming. Local leaders often possess the capacity to innovate based on local micro conditions. It is their scope to view issues from a wider lens without the constraints of fixed institutional mandates. Local leaders understand the challenges of local communities better than others. Capable local leaders are able to surmount these challenges with scarce resources and in difficult conditions. They continuously engage with their communities to educate, empower, and build skills that contribute to long-term community resilience. These roles give local leaders a significant comparative advantage in driving overall change.

An additional advantage they bring is their ability to include otherwise marginalised communities that often go unseen and unserved. This is critical since disaster losses disproportionately hit the poorest, most vulnerable in the cities. Local actors' role in ensuring inclusion and last mile connectivity are vital functions for minimising disaster losses. The concept of `leaving no one behind [UN, 2016]', which has caught traction in recent years riding on various global initiatives, gets served through this approach.

4. PEOPLE AT CENTRE

For SEEDS as a non-profit organisation working in the sector, addressing risk related problems in an urban setting posed a challenge. Unlike urban areas, rural communities, besides being small and defined by geography are also homogenous and better organised. In urban areas, besides complex governance mechanisms, citizens have migrated at different points in time, coming from different locations and prioritise employment at the cost of sub-standard living conditions and associated risks. Also, there is poor cohesion between neighbours and amongst clusters, tenure changes and housing changes hands fast, and there is less time and energy for social consolidation processes.

Establishing a Citizens' Forum to address local risk related problems was an experiment taken up by SEEDS originally in Delhi, and then replicated in other cities. It had not been attempted before in the country. The idea took inspiration from successful elements of community managed disaster risk reduction projects in rural contexts. Also, similar urban examples of Rotary Clubs and other such institutions provided some guidance on the distinct nature of organised citizen groups in urban areas. Moreover, risk reduction and disaster prevention is not an exclusive portfolio or department in local governments. At best, it is counted as a preparedness exercise by public emergency services. Hence, setting up a collaboration process between communities and local government was the most logical way to address challenges especially around extensive risks that cause everyday disasters. Citizens' fora fitted well in this regard as they had the local mandate and the systemic flexibility and agility to navigate the formal and informal engagements required [Gupta *et al*, 2019].

In October 2010, following a detailed stakeholder analysis, the `Purvi Dilli Apada Prehari' (PDAP: *English Translation: East Delhi Disaster-Watch Forum* [SEEDS, 2020b]*)*, was mobilised by identifying a few key influential individuals in the East District of Delhi. These individuals comprised representatives of existing local neighbourhood associations, academicians living in the area, retired government officials, members from local resident welfare associations, local leaders, NGOs, members of market association, *etc*. Through the years, PDAP has evolved to be recognised by district administration as a representative body addressing the local disaster risk reduction issues for the east Delhi community.

The Forum, in its early years, organised a series of meetings with other local groups and local government officials to shape the resilience discourse in the district. Continuous efforts were made through discussions and interactions to build a common understanding on risk related issues and its relevance in society for local actions. Secondly, efforts were made to build a perspective on building citizen and government partnership for leveraging and directing public resources to minimise locally assessed risks.

Overall, the process ensured there is a positive collaboration between citizens and the local government. On behalf of the citizens, the Forum was able to articulate specific needs where risks were high, and provided credible evidence for the same; the Government on their part created a listening and engagement space for such citizen action, and dovetailed their existing budgets and programmes to address highlighted needs.

A bottom-up pressure was created on various line departments of the local government through pro-active action, where citizens took upon themselves part of the civic services [Raval and Prajapati, 2007]. Media, especially social media, also was smartly used to engage the Government. A healthy partnership with the local government and citizens is now in place. There are regular interactions leading to improvement in service delivery, improvement in grievance redressal and mutual support activities in public programmes.

4.1 Mobilising the community: What was effective and what was not

The premise of forming the Forum was to facilitate a dialogue between the local government and the citizens to bridge the gap between disaster management related policies and practices at the district level. The deliberations through convergence workshops and other bilateral discussions have strengthened the connection between the Forum and the district government, ensuring inclusive developmental agenda with integrated risk reduction measures. The local level actions both by communities and government have set a good practice of the local level partnerships and level of complementarity.

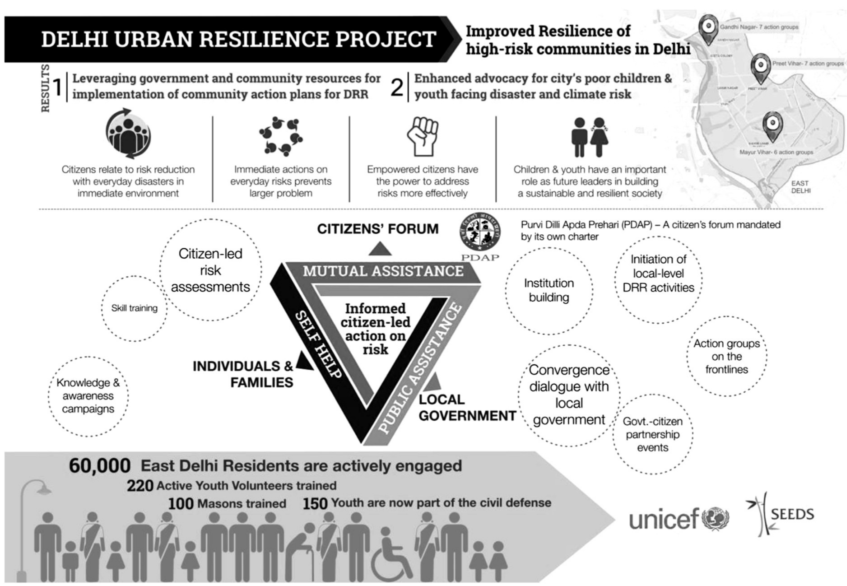

Figure 1: Principles of a citizen led urban risk reduction approach, as demonstrated under the SEEDS-UNICEF Delhi Urban Resilience Project, piloted in East Delhi [SEEDS-UNICEF, 2020]

Continuous handholding was carried out by the SEEDS team. Technical inputs were provided; training workshops were organised with Forum members, for example, on the use of legal mechanisms on accountability, *e.g.,* making use of the Right to Information Act [RTI, 2005], to get information from local government on their budgetary allocation for public services.

There have been useful spin-offs as the initiative has helped create an alliance of aware citizens, who have recognized the need to address underlying vulnerabilities and prioritizing actions that help in reducing stresses. The alliance has been benefitting over 60,000 citizens in the area. About 90 active members keep the work of the Forum alive and progressing.

4.2 Decentralised structure and volunteerism

About 215 local youth volunteers provided the `hands and legs' to the Forum's agenda. They quickly absorbed learnings from specially organised training programmes on disaster preparedness and prevention. Invisible risks – that of bullying, street-side violence, even domestic violence became part of the discussion as it localised. The youth became active providers of credible geo-tagged evidence that formed the basis of addressing areas such as poor public service delivery and safety and security issues for women.

The members of the Community Action Groups act as torchbearers to identify local risks and mitigate those risks in their own localities. These groups include women, children and youth, who are the most vulnerable of these communities. SEEDS team, with funding made available from its donors, provided seed funding to the Forum to implement tangible ideas on risk reduction. The Forum came up with demonstration projects like closed circuit television cameras being installed in public spaces, to be used for surveillance in neighbourhoods that reported frequent incidents of violence against women.

Overall, the bundle of activities carried out with the Forum has helped to bring in cohesiveness amongst the communities combating the common problems of urban stresses. Other local organizations have also joined in. Local cultural groups, sports clubs and trade associations have associated themselves with activities of the Forum, reinforcing the credibility and outreach of the Forum and its activities.

4.3 Getting Time and Commitment

While interacting with communities, it was observed that a large number had migrated to the city for work, making it extremely difficult for the team in SEEDS to mobilize individuals who could devote time for the community activities. The team made considerable efforts in having one-on-one dialogue with key individuals in their homes. This was followed with small group meetings, where local influential leaders were invited.

Ice-breaking and motivating youth and children was a challenge. A number of socialising activities were planned before the project related agenda could be taken up. Exposure visits, fun activities, friendly discussions, art and craft workshops and sports events were all part of trust building work.

5. BUILDING TRUST WITH THE GOVERNMENT AND A SENSE OF OWNERSHIP IN THE CITIZENRY

Getting a favourable response from the local government and line departments was a challenge. The public officials wouldn't take efforts by citizens' seriously until specific engagements and meetings were planned and results demonstrated. Further, with change of the local government officials, the relationships had to be re-established thus delaying further action. Mutual understanding and trust were gradually built when the Forum members stepped in to support Government's efforts where needed. E.g. crowd control during major public events. This was well received and reciprocated by the public officials by recognizing citizen efforts.

Creating the alliance of citizens has been challenged by the reluctance of the citizens to take up ownership of the Forum on a consistent basis. To continuously maintain their interest requires the Forum to regularly prove its worth through initiatives based on commonly felt needs. Local vested groups played their role in disrupting the unity of the Forum and its actions at a number of occasions. There were also fears that the Forum may become too political thereby losing its edge as a constructive collaborator with technically sound and credible group of citizens. The Forum required strong and selfless leadership to overcome biases. For this, leadership training was essential part of the handholding exercise carried out by SEEDS. Elections were conducted by the Forum and the new leadership has been much more responsive to needs of the citizens. Lately, the Forum has been able to charge a subscription from its members contributing in part to its financial sustainability. In the process the Forum has evolved as a strong and credible people's institution that can work independently, making the role of 'outsiders' such as SEEDS redundant.

5.1 Collectivisation and the Slow Process Involved

Thanks to all the donors and partners who provided resource support, the SEEDS team could commit to a necessarily long and slow process. It took some time for the community to move from "I" to "We" to "Our".

Creating an environment of positive bottom-up engagement with the government has built greater trust and accountability. Citizens used well-documented evidence as the basis, and well-articulated plans to engage with line departments. This provided legitimacy and credibility. The power and energy of young citizen volunteers was well harnessed to provide good outreach, and practice on the ground.

Overall, we felt that by building awareness on risks to everyday disasters, we are able to get traction on larger intensive risks that require policy approaches and other systemic changes. Such an approach has also opened the possibility of aiming at broader goals of sustainable development using resilience, risk reduction and protection as entry points, to a level where now conversations on larger issues like earthquake risk in East Delhi are able to get the group's attention and enable a positive and action oriented engagement without the need for much background work and awareness building.

5.2 The Link with the Master Planning Process

Town planning in the country follows the master planning process. The long horizon of 20 years in such a planning process is often questioned considering populations in cities sometimes almost doubles in this time [ICRIER, 2015]. But, in establishing an effective disaster prevention strategy this serves as the default time period as it aligns with the planning horizon. Disaster prevention is best achieved through establishing strong techno-legal regimes and land-use changes, and thus this tie to the master plan is important.

The importance of establishing a robust techno-legal regime in urban context is evident from the impact of earthquake that stuck two different countries in the western hemisphere in 2010. The first one hit Haiti on January 12th and the second one in Chile, just five weeks later [HP, 2010]. The Haiti earthquake killed over two hundred thousand people and in Chile, a five hundred times stronger earthquake claimed eight hundred lives. Apparently, the difference in mortality is due to location and depth of the two earthquakes. However, a deeper analysis reveals a number of factors as principal contributing causes. Chile has an excellent building code instituted in 1930s; Haiti has no building code and a vast majority of people lived in poorly constructed houses. Transparency international ranks Haiti at 168 and Chile at 25 in the least-to-most corrupt index. Little wonder**, then,** that governance related inefficiencies in Haiti led to large scale damage to buildings and the corresponding huge life loss.

6. LEVERAGING TECHNOLOGY TO ACHIEVE SCALE

A major fillip to citizen led disaster risk reduction and response has come from emerging technologies in recent years. `People as sensors' has been a term used to take ground level observations and weave them together as comprehensive risk and impact assessments. MIT's Urban Risk Lab has done work on this in recent years in different parts of the world, including India, using a web-based data gathering tool called Risk Map [RM, 2019]. The National Disaster Management Authority is piloting a Disaster Information Volunteer initiative in Uttarakhand through SEEDS and utilising the state's set up, wherein pre-identified volunteers from each district can relay information of local risks and impacts upwards, and can disseminate information from the authorities to the citizens. Such a system, once deployed at the national level, has the potential to speed up warning and response times and bring in great efficiency in the emergency management protocols.

Emerging work on artificial intelligence will change the way neighbourhoods use disaster related information to make decisions and to act for avoiding loss of lives and assets. Information about their inherent vulnerabilities will be available with a very specific context of their region and surroundings. Disaster alerts and warnings will be in forms that will tell them exactly what is expected in their current location and when, and what immediate action they should take. This will be backed with community plans that would have been prepared in advance through a consultative process. Sunny Lives is an initiative of SEEDS, with support from Microsoft, which is looking at using artificial intelligence for generating hyper-local disaster warnings and advice to enable very specific information to reach vulnerable families to take local action in time. In the longer-term perspective, it can also provide advice on reducing vulnerabilities and building capacities, down to the resolution of individual households.

The proposed approach involves the processing of very large volumes of data, virtually impossible to be carried out with manual processes involved. With each house, school, and public building of the country being a pixel with specific and unique attributes, data on vulnerability and warnings is being correlated and made available in an easy format. In particular, the warning data will need to be processed in near real-time.

Many of the attributes of location-specific vulnerability and anticipated disaster impact have to be derived from secondary information, such as the building material commonly found in a cluster/neighbourhood that tells us how it will behave in a storm or flood of a specific strength (NIDM, 2014). These interpretations are based on principles that can be programmed into machine learning and can be extended over wide geographies, with improvements over successive cycles.

7. URBAN DISASTER RESPONSE

Finally, the efforts on urban risk reduction through citizenry-based approaches will pay the ultimate dividends in terms of a more efficient and effective urban disaster response, saving lives and assets [Sanderson *et al*, 2014]. Cities with better access to resources make good investments in preparedness for response and reap benefits in reduced disaster impacts. In this model we are taking the population of the city itself as the most prominent resource. Urban emergency response has received much needed attention with training, skill and equipment, but even with the best of the investments, public response capacity remains limited. This is the reason why in most of the recent urban disasters, the local capacity is overwhelmed right from the beginning, and there is almost complete dependence on Central or State authorities.

The international Sphere standards [SS, 2018] provide specific guidance on emergency response in urban areas, and recognise the role of local responders, including local governments and civil society. Recognizing nuances of impacts in urban settings, the standards advocate for integrated approaches.

8. CONCLUSIONS

For a country like India, where despite recent economic advancements the resources available for disaster management remain grossly inadequate considering the scale and need for addressing disaster impacts, the most viable and abundantly available resource is the citizenry. Various lessons from within the country and outside have demonstrated that citizen led approaches have multiple benefits and are effective in achieving self-reliance in disaster preparedness as well as response.

Emphasis needs to be laid on Public-Private-People partnerships in the disaster management domain to realise the potential offered by each sector. For the part of citizen led action, the role of local leadership is an important peg. Finding local champions not only drives participatory change well, it also creates the opportunities to link it with local governance.

The process of fine-tuning the approach and making it customisable as a practice can be achieved well with the integration of disaster risk reduction in existing planning tools. Master Plans are the optimal platform for starting this process, and already have legal provisions for citizen participation, which can be used as entry points for resilience building not only at the planning stage but also in development, management and monitoring. Leveraging technology, especially in assessments and early actions, can give the cutting edge to the process. Use of platform-based approach for broader engagements, and dovetailing technologies and tools into people centric processes is the way forward to draw benefits from people's strengths and technological advancements at the same time. The future of urban disaster management is in the three domains of citizen centric approaches, local self-governance and modern technology, coming together.

References

1. Arya,A.S, (2000), "Non-engineered Construction in Developing Countries – an approach toward Earthquake Risk Reduction," Proceedings of the 12th World Conference on Earthquake Engineering, Auckland, New Zealand, 30 January - 4 February 2020, Paper 2824

   https://www.iitk.ac.in/nicee/wcee/article/2824.pdf

   Accessed on 10 October 2020

2. CoI, (2011), 2011 Census of India, https://censusindia.gov.in/2011census/PCA/PCA_Highlights/pca_highlights_file/India/Chapter-1.pdf

3. Gupta,M., Talankar,P. and Chavda,S., (2019), "Citizens of Delhi lead resilience action", Disaster Prevention and Management, Vol. 28 No. 1, pp. 69-75

   https://doi.org/10.1108/DPM-07-2018-0228

   Accessed on 10 October 2020

4. Gupta.,M. and Sharma.,A., (2002), *The Sustainable Community Rehabilitation Handbook*, United Nations Centre for Regional Development and Sustainable Environment and Ecological Development Society, Kobe

   https://reliefweb.int/sites/reliefweb.int/files/resources/73FF92540C803138C1256F9A00583186-Community_Rehabilitation_UNCRD_Oct_2002.pdf

   Accessed on 02 May 2018

5. Hamdi, N., (2010), *The Placemaker's Guide to Building Community*, Earthscan

6. HP, (2010), Haiti vs Chile: the Earthquake Olympics

   https://www.huffpost.com/entry/haiti-vs-chile-the-earthq_b_518639

   Accessed 6 October 2020

7. ICRIER, (2015), Planning for urban development in India

   http://icrier.org/Urbanisation/pdf/Ahluwalia_Planning_for_Urban_%20Development.pdf

   Accessed on 10 October 2020

8. NIDM, (2014), *Mainstreaming Disaster Risk Reduction in Housing Sector*, National

Institute of Disaster Management, Ministry of Home Affairs, Government of India

9. Rawal,V., and Prajapati,D., (2007), *Assessing Damage After Disasters – A Participatory Framework and Toolkit*, Unnati, Ahmedabad

   http://www.unnati.org/pdfs/books/damage_assessment_toolkit.pdf

   Accessed 02 May 2018

10. RM, (2019), Risk Maps for various locations

    www.riskmap.in

    Accessed 8 October 2020

11. RTI, (2005), The Right to Information Act, 2005

    https://rti.gov.in

    Accessed on 10 October 2020

12. Sanderson,D., Sharma,A., Kennedy,J. and Burnell,J., (2014), "Lost in Transition: Principles, Practice and Lessons from Haiti for Urban Post Disaster Shelter Recovery Programs," *Asian Journal for Environment and Disaster Management*, Research Publishing Services, Singapore

13. SEEDS, (2020a), Sustainable Environment and Ecological Development Society, Delhi

    http:// www.seedsindia.org

    Accessed on 10 October 2020

14. SEEDS, (2020b), Building local level resilience through citizens platforms

    https://www.seedsindia.org/portfolio/building-local-level-resilience-through-citizens-platforms/

    Accessed on 10 October 2020

15. SEEDS-UNICEF, (2005), Delhi Urban Resilience Project:

    https://cfsc.niua.org/sites/default/files/SEEDS-UNICEF-East%20Delhi%20project%20summary%20051217.pdf

    Accessed on 6 October 2020

16. SS, (2018), The Sphere Handbook 2018

    https://spherestandards.org/handbook-2018/

    Accessed on 20 November 2020

17. Surjan,A., Redkar,S., and Shaw,R., (2009), *Chapter 17: Community-based urban risk reduction: Case of Mumbai*, in L.Cai, H.Srinivas, and A.Sharma (Eds.), *Community, Environment and Disaster Risk Management*, pp 339-354

18. TERI, (2015), Climate change impacts are also driving changes in risk profiles through urban development

https://www.teriin.org/projects/apn/pdf/maharashtra/Impact_of_climate_change_on_urban_development.pdf

Accessed on 12 October 2020

19. TCPO, (2020), Town and Country Planning Organisation, Ministry of Housing and Urban Affairs, Government of India

    http://www.tcpo.gov.in

    Accessed on 6 October 2020

20. UN, (2015), Report of the UN

21. *https://www.un.org/sustainabledevelopment/blog/2015/11/un-report-finds-90-per-cent-of-disasters-are-weather-related/*

    Accessed on 12 October 2020

22. UN, (2016), Report of the UN on Leave No One Behind (LNOB) and the Sustainable Development Goals 2030

    https://unsdg.un.org/2030-agenda/universal-values/leave-no-one-behind

    Accessed on 12 October 2020

23. UNDP, (2017), Social vulnerability assessment tools for climate change and DRR programming

    https://www.adaptation-undp.org/Social-Vulnerability-Assessment-Tools

    Accessed on 10 October 2020

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Impact of Disasters on the Environment

Abstract: Disasters (both natural and manmade) impact adversely human life, property and the environment. While well thought-out post-disaster management responses can mitigate the cost of the impact, pre-disaster planning can minimise the severity of the disasters, save human life, property and safeguard the environment. This paper analyses these aspects with the help of two specific case studies pertaining to Visakhapatnam – the first one, the Hudhud cyclone that occurred in October 2014, and the second one, the LG Polymers styrene gas leak accident in May 2020. The analysis yields important lessons on how pre- and post-disaster planning and precautionary measures can minimise the adverse disaster impacts.

Key words: Planning, management, pre-disaster, post-disaster, hazardous industries and industrial safety

1. INTRODUCTION

A disaster is a hazardous event that causes significant injury to the environment, human life and/or property. It can be nature-induced (*e.g.,* cyclones and floods) or anthropogenic (*e.g.,* industrial accidents). It can have a sudden impact on life as in a cyclone or slow deterioration of life support as in industrial pollution. Advance ecological planning can mitigate the impact of a natural disaster, like a cyclone. Early warning systems help the authorities to alert the affected people and minimize the damage. Lessons drawn from each disaster can help to evolve sustainable mitigation approaches. Application of the state-of-the-art technologies can minimize risks and adverse outcomes.

The following sections provide a review of the pre- and post-disaster responses of the administration and the civil society to two specific instances of disasters that occurred in the Visakhapatnam the region in Andhra Pradesh (AP) in recent times. The cases chosen are: (1) the HudHud cyclone of October 2014, and (2) the gas leak accident at LG Polymers unit in May 2020. Both of these disasters caused widespread adverse impact on the environment and the local community. The first one was a natural disaster, and the second, a man-made disaster. Before examining these two cases, it's helpful to appreciate the geographic location, the terrain, and the urban characteristics of Visakhapatnam having relevance for examining each of these two cases.

2. VISAKHAPATNAM URBAN AGGLOMERATION

Visakhapatnam is a major coastal urban agglomeration in AP. The city is nestled in a basin-like region surrounded by hills on three sides and the Bay of Bengal on the east. it has an undulating terrain with the seasonal monsoon rain waters precipitated over the hills, flowing rapidly into the sea through a number of streams and drains. Some portions of the land near the coast, including that in which the airport is located consist of marshy stretches prone to flooding when there is a sudden heavy downpour, coinciding in time with the high tide in the sea. The estuary near the port has large patches of rich mangroves that have come under pressure from the dredging operations of the port and the construction activity nearby.

The population of the city in 2011 was 17.28 Lakhs, of which about 45% lived in "slums" [CoI, 2011], a euphemism for highly unhygienic parts of the city, where the low-income families of the workers who maintain the city's day-to-day activity is forced to live as a result of faulty urban planning. As a result of the influx of migrant workers in search of employment from the surrounding rural areas, the city is growing rapidly in terms of both its urban sprawl and population. There are several fishing habitations along the seafront, which have come under intense pressure from the forces of urbanization and industrialization.

The city has two ports catering to the vast hinterland, an oil refinery, two large power generation plants, a large steel plant, and numerous industrial units located all around. The Central Pollution Control Board (CPCB) categorized the Visakhapatnam industrial cluster to be among the top 40 "critically polluted" ones in the country [IWP, 2020].

3. CASE 1: HUDHUD CYCLONE

While Visakhapatnam and its surroundings are prone to cyclonic weather during the monsoon season, the HudHud cyclone that crossed the coast near the city in October 2014 was one of the most damaging ones. The Vulnerability Atlas of India [BMTPC, 2019] categorized Visakhapatnam urban area and its surroundings as located in a high wind-speed, "cyclone occurrence" region and a "very high damage risk zone". The Inter-governmental Panel on Climate Change (IPCC) studies [Pörtner *et al*, 2019] suggest there will be "increased intensity of multiple events and the associated cascading impacts" around the tropical coastal regions in countries, like India. The frequency and the intensity of cyclones crossing the east coast may thus increase in the coming decades due to climate change effects caused by anthropogenic factors. A collective global effort to mitigate this can contain this trend to some extent.

The National Disaster Management Authority (NDMA) has analysed the HudHud impact in their report [NDMA, 2015]. HudHud, categorized as a "Very Severe Cyclonic Storm (VSCS)" with a maximum sustained wind speed of 180km/ hour (at times it exceeded 200km/ hour) hit the east coast at Visakhapatnam on 12 October 2014. It's "eye" crossed the densely populated urban agglomeration of the city, causing severe devastation and disrupting the lives of the people for more than ten days. The Indian Meteorological Department (IMD) had tracked the cyclone ever since 6 October 2020, when it was at its initial stage of the formation near the north Andaman Sea. Thus, the administration had six days' time to alert the people, evacuate them to safe places, and arrange relief for them. HudHud came with strong winds and moderate precipitation. The rainwater caused water-logging at some places due to the clogging of the drains. A maximum storm surge of 1.4 m above the astronomical tide was reported by the tide gauge at Visakhapatnam. Since the beach had already got eroded severely at places, this caused serious concern to those who resided along the coast, including the fishing habitations. The houses of the fishermen close to the sea were uprooted and their boats heavily damaged.

HudHud affected 92 Lakhs people in over 7,285 villages in 4 coastal districts, resulting in 61 human causalities. It caused extensive devastation in the affected districts, brought down a number of trees, damaged roads and buildings (including the airport building), and disrupted power and telecommunications infrastructure. Uprooted trees blocked the roads at several places causing logistic problems for relief activity. There was a shortage of power saws to cut and remove the uprooted trees quickly and it affected the relief work significantly. Early warning systems helped the authorities in organizing relief camps and providing basic amenities to those affected, thus minimizing the casualties.

The following are the important environment and community-related concerns arising in the case of HudHud:

(1) The city's ecosystem: To what extent was the city's ecosystem cyclone resilient? Had the urban planners integrated ecosystem development into their disaster management approach, would the risks and the damage due to HudHud have been less?

(2) Community's capacity to face the cyclone: To what extent the affected communities had the capacity to withstand the cyclone fury? How can they be adequately prepared for the future?

(3) The city's infrastructure: To what extent the city's infrastructure was cyclone resilient? How can it be strengthened?

3.1 The City's Ecosystem

"*The best time to plant a tree was twenty years ago. The second best time is now*" says a Chinese proverb. The city's planners should have realized the value of ecosystem planning in mitigating the impact of HudHud-like cyclones. Rapid urbanization and indiscriminate industrialization have eroded the ecology of the city over time. The NDMA has rightly pointed out [NDMA, 2015], "well-managed ecosystems help in reducing vulnerabilities to natural disasters and in mitigating the impacts from hazards, aiding recovery and reducing damages. These ecosystem benefits should be integrated into disaster prevention, mitigation, and adaptation strategies. Thus there is a need to maintain shelter-belts and mangrove plantations in coastal areas." Pre-and post-HudHud responses suggest no such integrated planning was in place. Instead of protecting the existing mangroves and the other shelter plantations, the planners allowed urban growth and industrialization to denude the tree cover during the last few decades.

A sample study carried out [Swaini *et al*, 2009] on a stretch of mangroves near the Visakhapatnam Port found that: "*the mangrove cover is eroding fast due to dredging activities by the Port Authority. About 50% of mangroves of the area have been depleted in recent times. The dredging of the stream started in 2006 to protect airports from flooding. Conservation of the remaining mangrove cover of this area is the need of the hour. The State forest department should take immediate action to protect the mangroves. The use of geospatial technology could provide valuable and spatially explicit information about the present status and degradation of mangrove cover in the study area. The areas where mangroves have already been cleared should be put into reforestation activities. Further decline of mangrove cover must be protected before it is too late.*" Official neglect continues to cause further depletion of the mangroves lying between the airport and the Visakhapatnam Port.

The shelter plantations along the city's coastline also are fast disappearing. Notified forest lands along the coast are being diverted for tourism and other projects, on the ground that alternate non-forest lands are offered elsewhere for "compensatory afforestation," a concept that has been made mandatory by the apex court of India in its landmark judgment in the well known Godavarman Case [SCoI, 1995]. CAG's report [CAG, 2013] on compensatory afforestation in different States including AP revealed how, in actual practice, the concept had largely remained a non-starter. To cite an example, about ten acres of notified forest land were diverted for the Karthikavanam "eco-tourism project" near Yendada village on the city's coast [AP, 2013]. Though the authorities had got the project cleared on an assurance that non-forest land twice that extent would be provided for raising an alternate forest stretch elsewhere, in reality, the assurance remained unfulfilled. There have been several instances of such loss of shelter forests on the coast during the last decade or so.

Had the concerned authorities undertaken an extensive mangrove restoration program, conserved the existing shelter plantations, and raised new shelter plantations along the coast, the coastal ecological system would have got strengthened to that extent and become resilient to cyclonic storms, like HudHud. Within the city area, it is the native species of trees that largely withstood the cyclone fury, whereas it is the exotic species that gave in. The authorities are yet to wake up to this reality, as they continue to incur heavy public expenditure on raising non-native species of trees, which may not withstand strong winds as in the case of HudHud.

3.2 The City's Community Preparedness

"The cyclone or any other disaster can be addressed only if steps are taken beforehand in preparing for mitigation of their effects. Risk preparedness needs to take into account the involvement of right NGOs and the Private Sector from the community to various stakeholders, like Government" [NDMA, 2015].

As already indicated, the slum dwellers and the fishing communities constitute a large proportion of the city's population. The impact of Hud Hud on them was two-fold. It blew away their makeshift shelters and rendered them homeless. They live on in inhospitable areas such as the hill slopes on the outskirts, along the city's drains, and along the railway track. Their habitations are sub-human, as they lack the basic amenities, such as sanitation, public toilets, potable water supply, and electricity. The residents attend to nature's calls in the open. For the sake of privacy, women resort to open defecation late in the evening when it is dark. They are exposed to snake bites and other hazards. Hud Hud made it worse. With a view to providing the light, a civil society body, *Forum for Better Visakha (FBV)* raised public donations in kind, in the form of solar lamps, 4,800 of which were distributed to the slum dwellers.

FBV also set up 10 solar street lights in the slums where there were needed. In one colony, school children were provided solar lamps to enable them to carry on their work at home. In times of crisis, it became evident that solar energy can be a lifesaver.

With a view to rehabilitate the fishing communities whose houses got uprooted by Hud Hud, the authorities tried to rehabilitate them in a government housing complex located 5 to 6km inland, from where the fishermen found it difficult to access the sea for their daily fishing activity. For that reason, the rehabilitation scheme never took off.

3.3 The City's Infrastructure

(a) Cyclone Shelters

Drawing lessons from the past cyclones in AP, the State Government had set up 975 cyclone shelters along the coastline (146 along the Visakhapatnam stretch) in the past, where those directly exposed could take shelter and have access to some basic amenities. According to the World Bank assisted National Cyclone Risk Mitigation Project (NCRMP) prepared by the State Panchayati Raj Department in May 2009 [AP, 2009], 876 of them were in good condition as in 2009. It was then proposed to set up another 148 shelters. As on the date of occurrence of Hud Hud in 2014, most of the shelters became dysfunctional. If those shelters were placed under the communities' oversight, especially that of the fishing communities with sufficient funds, tools, equipment, etc., and placed at their disposal, the shelters could have come to the rescue of the affected families. Therefore the authorities had to incur additional expenditure on makeshift relief camps, close to the beach to provide shelters to the affected.

In the matter of building community capability to face severe cyclones, the Government of AP may draw lessons from Odisha's UNESCO-assisted scheme implemented in two villages, namely, Noliasahi in Jagatsinghpur district and Venkatraipur in Ganjam district, which was affected by the 1999 Super Cyclone [UNESCO, 2020]. "*Our community would like to thank UNESCO-IOC* *for this recognition, and for enhancing the sustainability of our community against tsunami hazard,*" remarked Appa Rao, Community Leader at Venkatraipur Village. "Tsunami Ready" recognition is achieved by satisfying multiple initiatives. These include conducting a community tsunami-risk reduction program, designation and mapping of tsunami hazard zones, public display of tsunami information, easily understood tsunami evacuation maps, outreach, and public education materials, participation in mock drills, community emergency plans, and the presence of reliable 24-hour early warning system. The AP authorities should undertake an elaborate community capacity-building program on the above lines and prepare the local communities to face cyclonic weather conditions along the 974 km long coastline.

(b) Infrastructure

Both the power distribution poles and wires and the telephone and broadband communications networks were affected severely as a result of the cyclone. The response from the private companies operating the telephone and broadband communications were woefully inadequate while that of the AP Eastern Power Distribution Company Limited (APEPDCL), a State PSU, was remarkably prompt and efficient. The roof cover of the airport building was blown away as it was never designed to withstand the strong winds that Hud Hud generated at times. It took several months to bring back the airport operations to normalcy. In general, it is necessary to review the stability of the communications networks, the structures at the ports, the airport, the railway station, the inter-state bus terminal, wireless towers, and so on and upgrade them to be able to withstand up to 300 kmph cyclonic winds.

As a part of the post-Hud Hud rehabilitation plan, APEPDCL approached the World Bank for funding an ambitious underground electric cabling (UGC) project to insulate the electricity distribution network from cyclones. While the UGC will undoubtedly insulate the electricity supply system from the surface wind fury, it is highly capital intensive, vulnerable to risks of delays and cost escalation. Foreign currency loans, which the World Bank provides, also are subject to exchange rate variation. Any increase in the unit cost of electricity will ultimately affect the consumers' interests. The COVID 19 crisis has already caused delays in the progress of the UGC project, which will impose a heavy cost burden on the electricity consumers.

Once such a heavy investment is sunk on UGC, in the long-run, the other cost-effective options, such as roof-top solar electricity generation, will get foreclosed. From the environment point of view, the State government should perhaps have evaluated the roof-top solar option in preference to making a large investment on UGC, which largely caters to a centralised generation of electricity, tilted heavily in favour of coal and the high transmission losses that characterize any centralized generation system. From the point of view of climate concerns, it is desirable to move away from coal to solar energy and from centralized generation to distributed generation.

4. CASE 2: LG POLYMERS GAS LEAK ACCIDENT

The LG Polymers (LGP) unit is located at R. R. Venkatapuram village in Pendurty Mandal in Visakhapatnam. A fatal accident occurred at the unit at midnight on 7 May 2020, resulting in 12 deaths, hospitalization of 585 persons, and many more falling unconscious, semi-conscious, feeling nausea, breathing difficulties, skin rashes, and eye irritation. The immediate impact of the gas leak could be felt as far as 5.0–7.5 km from the accident site. In the final analysis, the loss of life and injuries could be more.

The existing unit of LGP was originally set up in 1961 to manufacture alcohol from molasses, when the population density around Venkatapuram village was comparatively less than at present. The unit changed hands several times over the last seven decades and evolved into a unit importing the hazardous chemical, Styrene for manufacturing Polystyrene, Expandable Polystyrene and Engineering Plastics at the same location, where the population density all-around has increased in leaps and bounds.

The promoters of the LGP unit expanded the capacity of the unit progressively and the AP Pollution Control Board (APPCB), the body responsible under the Air (Prevention & Control of Pollution) Act and the Water (Prevention & Control of pollution) Act to regulate industrial pollution, allowed the capacity expansions, knowing well that in a thickly populated neighbourhood, such as this one, such expansions would not be in the public interest. In 2006, the Union Ministry of Environment notified the Environment Impact Assessment (EIA) rules under the Environment Protection Act, which made it mandatory for industrial units to obtain *prior* Environment Clearance (EC) before capacity expansion, based on a comprehensive study of the environmental implications of the proposed expansion and a public consultation process to assess the impact on the people. LGP failed to obtain an EC for the three capacity expansions that took place in 2014, 2015, and 2017 [EC, 2019]. Despite this lapse, APPCB cleared the expansions without adequate application of mind. While APPCB thus imprudently approved the successive expansions of the unit, the local urban planning authorities who were required to disallow residential layouts in the vicinity of hazardous industrial units also violated the norms of safety and allowed residential complexes to come up next to the unit's compound wall.

On the part of LGP, the High Power Committee (HPC) appointed by the State Government to investigate the LGP accident found serious safety lapses on the company's part [HPC, 2020]. The accident resulted in the release of more than 560 tonnes of Styrene into the atmosphere. Styrene has been notified as a "hazardous" chemical under the Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 (MSIHCR). The company did not engage a sufficient number of qualified persons to run the unit and deal with emergencies. There were serious shortcomings in the design of the Styrene tanks and there were no adequate temperature measuring devices to forewarn the operators of an impending emergency. The MSIHCR and the Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996 (CAEPPER) require the unit's managers to have an emergency plan ready and six-monthly mock drills conducted to test it at the site so that, in the event of an accident, the emergency plan can be implemented to minimize the damage. LGP had no such plan in place. Even the emergency alarm system of the unit failed to function, when the Styrene gas started leaking into the air [HPC, 2020].

After the ghastly gas leak accident that took place at the Union Carbide's plant at Bhopal in Madhya Pradesh in 1984, the Factories Act was amended in 1987 to incorporate additional regulatory safeguards to enhance industrial safety. Had the concerned regulators empowered enforced those safeguards in time, the LGP accident could have been prevented.

(a) Impact of LGP Accident on the Environment

Styrene gas has both short-term and long-term impacts on the environment and the health of the people residing in the area. The International Agency for Research on Cancer has determined that styrene is possibly carcinogenic to humans based on "limited evidence of carcinogenicity in humans and laboratory animals" [NLM, 2020]. Depending on the wind speed and its direction at the time of the accident, it is possible that the Styrene impact extended beyond 10km from the accident site, as people far away could smell the odour and felt choked.

A rough back-of-the-envelope estimate shows that, if the released Styrene got deposited within a radius of 1km, it would amount to 177 grams/m^2, and in 5 km around 7 grams/m^2. It is necessary to assess as to how far the Styrene so released has affected the residents of the area and to what extent. Around 1,00,000 people reside within 10km from the site of the accident. The Meghadrigedda reservoir that provides drinking water for the city is 0.5 km from it. There is agricultural activity in its immediate vicinity. There are four biodiversity-rich forest blocks within the impact area, namely Kailasakonda (0.5 km), Narava (0.5 km), Yerrakonda (4.3 km), and Kambalakonda (5.4 km). Out of these, Kambalakonda block has a protected wildlife sanctuary notified under the Wild Life (Protection) Act, 1972 [EC, 2018].

Had the authorities collected blood and urine samples from the residents at least up to 10km from the site of the accident and carried out an analysis, one could get a rough idea of the extent of the accident impact. Similarly, the impacts of the accident on the flora and the fauna of the forest blocks also needed to be assessed. No such comprehensive assessment appears to have been done in a timely manner. More important, it is desirable that the health of the people residing at least within 10 km of the accident site is monitored on a long-term basis to find out whether Styrene has resulted in carcinogenic and other long-term diseases. There are two sets of judicial proceedings going on in the case of the LGP accident.

The AP High Court initiated *suo moto* proceedings and two persons joined the same by filing petitions on their behalf [HCoAP, 2020]. These proceedings cover a wide range of concerns such as violation of the environmental and the other related laws by LGP, the company's liability for environmental and public health impacts, enforcement of the Public Liability Insurance Act, and the action to be taken against the Officers found to have committed lapses.

The National Green Tribunal (NGT) also took *suo moto* cognizance of the accident, directed LGP to deposit Rs.50 Crores by way of interim relief and appointed a high power committee headed by a senior member of the judiciary to enquire into the circumstances leading to the accident. On the basis of that committee's findings, NGT came to the conclusion that LGP was negligent and therefore should bear "absolute liability" for the damage. There are two separate petitions filed before the NGT including one by the author of this paper seeking action against the regulators for their lapses, seeking a direction to be issued to LGP to pay for the environmental damage and for setting up a committee to settle the claims of the affected persons [NGT, 2020]. Both these cases are pending final adjudication.

(b) Industrial safety

There are 2,900 industrial units located in the three districts of Srikakulam, Vizianagaram and Visakhapatnam. Of these, at least 93 units deal with hazardous chemicals [APPCB, 2020]. During 2014-18, for which the information is readily available [AP, 2019], as many as 1,547 fatal industrial accidents took place in the State. In and around Visakhapatnam, especially in the Pharmacy complex near Paravada village nearby, it is in the public the knowledge that a series of fatal accidents took place one after the other during the last decade and such accidents continued to occur even after the LGP accident. Had the regulators been sufficiently vigilant, they would have held the concerned managements responsible for the damage and imposed deterrent penalties on them. Each industrial unit non-compliant with the safety protocols presents a potential disaster in waiting. Preventive action in such cases can save many human lives and damage to the environment

5. CONCLUSION

The lessons from above analysis are given below:

(1) Integrating advance ecological planning as a part of urban planning can mitigate the impact of the HudHud-like disasters in the coming decades.

(2) A professional approach to building the capacity of the local communities needs to be developed and adopted. Community preparedness should be tested from time to time through mock drills.

(3) The structures and the facilities associated with the infrastructure utilities need to be redesigned so as to ensure that they can withstand super cyclones touching wind speeds of 300 kmph.

(4) A comprehensive industry safety audit should be conducted periodically and those units that habitually fail to comply with the statutory safety norms should not only be penalised, but closed down.

References

1. AP, (2009), National Cyclone Risk Mitigation Project, Panchayati Raj Engineering Department, Government of Andhra Pradesh
https://ncrmp.gov.in/wp-content/uploads/2014/03/IP_AP_Part1.pdf
Accessed on 20 November 2020

2. AP, (2013), "CRZ Clearance for Development of 4.0 Ha of forest land in Visakhapatnam Division for Karthikavanam," Infrastructure and Miscellaneous Projects & CRZ: Item 15. IA/AP/MIS/395/2013 - 11-12/2013-IA-III

http://environmentclearance.nic.in/search.aspx

Accessed on 20 November 2020

3. AP, (2019), Statistical Abstract of Andhra Pradesh, Government of AP
4. APPCB, (2020), District-wise Inventory of Hazardous Waste Generation in Andhra Pradesh

   https://pcb.ap.gov.in/hazordous/HMW-inventory.pdf

   Accessed on 20 November 2020
5. CAG, (2013), "Compensatory Afforestation in India, Report of the Comptroller and Auditor General of India, Union Ministry of Environment & Forests, Report No 21/2013- Compliance Audit
6. CoI, (2011), Census of India

   https://www.census2011.co.in/census/city/402-visakhapatnam.html

   Accessed on 20 November 2020
7. EC, (2018), LG Polymers Application, 02 January 2018

   http://environmentclearance.nic.in/writereaddata/Online/TOR/02_Jan_2018_194245067RCL5MO0QLGPolymersTORApplication.pdf

   Accessed on 20 November 2020
8. EC, (2019), Conceptual Plan, 10 May 2019

   http://www.environmentclearance.nic.in/writereaddata/FormB/TOR/ConceptualPlan/10_May_2019_1907099537XGSWYR2EDSReply.pdf

   Accessed on 20 November 2020
9. HCoAP, (2020), Writ Petitions, Nos. *112/2020, 117/2020, 119/2020*, Order dated 22 May 2020, The High Court of Andhra Pradesh

   http://hc.ap.nic.in/docs/WP(PIL)112,117,119OF2020.pdf

   Accessed on 20 November 2020
10. HPC, (2020), "The Report of the High-Power Committee on the Styrene Vapour Release Accident at M/s LG Polymers India Private Limited," AP State Government

    https://www.ap.gov.in/wp-content/uploads/2020/07/The-High-Power-Commitee-Report.pdf

    Accessed on 20 November 2020
11. IWP, (2020), Water Portal of India

    https://www.indiawaterportal.org/sites/indiawaterportal.org/files/Comprehensive%20Environmental%20Assessment%20of%20Industrial%20Clusters_Central%20Pollution%20Control%20Board_MoEF_2009.pdf

    Accessed on 20 November 2020
12. NDMA, (2015), "Cyclone HudHud: Strategies and Lessons for Preparing Better & Strengthening Risk Resilience in Coastal Regions of India,"

National Disaster Management Authority

https://ndma.gov.in/images/pdf/Hudhud-lessons.pdf

Accessed on 20 November 2020

13. NGT, (2020), National Green Tribunal Original Applications 73/2020 and 76/80/2020
14. NLM, (2020), Details of Styrene

    https://pubchem.ncbi.nlm.nih.gov/compound/Styrene

    Accessed on 20 November 2020
15. Pörtner,H.-O., Roberts,D.C., Masson-Delmotte,V., Zhai,P., Poloczanska, E., Mintenbeck, K., Tignor,M., Alegría,A., Nicolai,M., Okem,A., Petzold,J., Rama,B., and Weyer,N.M., (2019), "IPCC, 2019: Technical Summary," in *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* by Pörtner,H.-O., Roberts,D.C., Masson-Delmotte,V., Zhai,P., Tignor,M., Poloczanska,E., Mintenbeck,K., Alegría,A., Nicolai,M., Okem,A., Petzold,J., Rama,B., and Weyer,N.M., (Eds.)

    https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/04_SROCC_TS_FINAL.pdf

    Accessed on 20 November 2020
16. SCoI, (1995), "T.N. Godavarman Thirumulkpad *versus* the Union of India & Othrs," Writ Petition (Civil) No. 202/1995, Order dated 12 December 1995 ,The Supreme Court of India
17. Swain,P.K., Rao,N.R., and Pattanaik,C., (2009), "Mangrove Forest Cover of Visakhapatnam Coast is under Threat," *Current Science*, Indian Academy of Sciences, Bangalore, Vol.97, No.8, 25 October 2009 *https://www.currentscience.ac.in/Downloads/article_id_097_08_1112_1113_0.pdf*

    Accessed on 20 November 2020
18. UNESCO, (2020), Report on "Communities in Odisha State receive Tsunami-Ready Recognition," 20 August 2020

    https://en.unesco.org/news/communities-odisha-state-india-receive-tsunami-ready-recognition

    Accessed on 21 November 2020
19. BMTPC, (2019), Vulnerability Atlas of India, Building Materials and Technology Promotion Council, Ministry of Housing and Urban Affairs, New Delhi

    https://bmtpc.org/DataFiles/CMS/file/VAI2019/cy.html

    Accessed on 20 November 2020

K. M. Singh

Creating the National Disaster Response Force

Abstract: In a short span of less than 15 years, the NDRF has earned a niche for itself for its professionalism and commitment in dealing with major disasters within the country and abroad. It is a multi-disciplinary and multi-skilled force trained and equipped as per international standards to deal with natural as also CBRN disasters. The commendable work done by the NDRF in the aftermath of the Fukushima nuclear leakage in the Great East Japan Earthquake in 2011 was a shinning example of trans border operations in disaster response and a matter of great pride for the NDRF in its first international deployment.

Key words: Response, Origin, Equipment, Operationalisation, Deployment

1. INTRODUCTION

It is indeed very heartening to note that the National Disaster Response Force (NDRF), the youngest Central Police organisation in the country, has acquired in a short span of 14 years a niche for itself for its professionalism in handling disaster situations. It is a multi-disciplinary, multi-skill, high-tech specialist force capable of handling all *natural disasters* and *Chemical, Biological, Radiological and Nuclear (CBRN) emergencies*. Also, it has acquired the unique distinction of being the single largest dedicated *Disaster Response (DR) Force* in the world.

2. FORMING THE NDRF

Since its inception to its present shape, the journey of NDRF has been a steep uphill task with innumerable impediments, and overcoming the same has been a daunting experience. But, first a few words about its inception. As the DG CISF, I had the privilege of being a Member of the Steering Committee headed by the then Union Home Secretary, Shri N. Gopalaswamy, constituted to decide the format of disaster response (DR) mechanism in the country in 2003. The credit for envisioning the concept of having 8 Battalions (Bns) of NDRF drawn from four Central Police Organisations (CPOs) goes to Shri R. K. Singh, the then Joint Secretary (Disaster Management) in the Ministry of Home Affairs (MHA). He not only conceived the concept of NDRF, but secured of the approval of the Union Cabinet to acquire 310 equipments for ₹ 290 Crores for each of the proposed 8 Batalliions (Bns) of NDRF. He was also actively involved in drafting the Disaster Management (DM) Act 2005, which enjoined upon the National Disaster Management Authority (NDMA) the responsibility of superintendence, direction and control of the NDRF.

Shortly after constitution of the NDMA, a meeting with the Director Generals of four paramilitary forces of India, namely BSF, CRPF, CISF and ITBP, was convened under the chairmanship of the Vice Chairman of NDMA, Gen.(Retd) N. C. Vij, in October 2005 to seek their support to set up the force (later named as NDRF) by providing the personnel sanctioned for each of the 8 Bns. The lukewarm response of the DGs to extend the desired support made us to realise that establishing this force would be a difficult task. While the efforts to get the support of the DGs were on, a missive from the Army Headquarters (Hqrs) came as yet another blow. It was a cogently drafted proposal from Army Hqrs, received in the NDMA through Ministry of Defence (MoD) and MHA, asking that all the 8 NDRF Bns be given to Army. The argument was that since the Army has vast experience of handling disasters, it would be able to provide experienced personnel from all disciplines to establish the NDRF and make all the 8 Bns fully functional within six months. The merit in the proposal of Army Hqrs *vis-a-vis* the impediments and limitations to set up this force with personnel from the Central Police Organizations (CPOs), notwithstanding, NDMA argued the case vehemently in support of the CPOs. After protracted correspondence for months, this issue was finally clinched in favour of the CPOs with the argument that NDRF is a statutory force under Sections 44 and 45 of the DM Act, 2005 and if NDRF is given to the Army, it will be the first instance of the Army being given a statutory role in matters relating to internal security. It was contended further that even after constitution of NDRF, the Army will still be requisitioned in any major disaster as aid to civil authorities.

3. EQUIPPING THE NDRF

Various problems relating to procurement of 310 equipments, for which there was neither any *Quality Requirement (QRs)* nor wherewithal with the NDMA for their procurement constituted the next hurdle. Since most of the items were new and no specification was available with any organisation, NDMA engaged the services of Maj. Gen. (Retd.) Mukherjee (former Additional Director General (Weapons & Equipment)), Indian Army) and constituted a committee led by him, which produced a voluminous document with detailed specifications of all the items after a painstaking efforts lasting six months.

The next problem that the NDMA was confronted with related to actual procurement of these 310 equipments. The Procurement Division of MHA expressed its inability to accept this huge responsibility of procuring such large quantity of equipment for all the 8 Bns due to limitation of human resources with them. The DG, who was holding the additional charge of NDRF, also was handicapped in undertaking this responsibility as there was no sanctioned staff for NDRF Hqr. The four CPO Chiefs also declined to take up this additional responsibility. After exhausting all options, NDMA engaged the services of Ms. Somi Tandon, who had retired as Secretary and Financial Advisor, MoD, and had vast experience in the field of procurement. The committee constituted, which was led by her, after detailed deliberations, distributed the 310 items under two categories of low value and high value. It recommended that the low value items may be procured by the Commandants of respective Bns under their delegated powers. The remaining high value items were distributed under four different heads with the responsibility of procurement under each of the four heads assigned to the four CPOs. The four DGs were persuaded to accept this responsibility, which they accepted grudgingly. Realising that procurement of all the equipments was critical towards effective operationalisation of the NDRF, NDMA monitored this process closely and ensured that most of the procurement was completed by around 2008.

4. OPERATIONALISING THE NDRF

An equally important factor in effective operationalisation of NDRF as a professional force was availability of manpower and their proper training. As per the Cabinet approval, each NDRF Bn was authorised 1145 personnel, but since the CPOs had their own priorities and constraints of manpower, the availability of manpower in each of the NDRF Bns remained abysmally inadequate. The problem was compounded by the the skeletal manpower available in each of the NDRF Bns was being diverted regularly by the MHA for routine law & order and Internal Security (IS) duties, sometimes even withdrawing the personnel mid way from various DR trainings. In a series of meetings in the MHA, even with the Hon'ble Home Minister (HM), NDMA stressed upon the importance of training of NDRF personnel and their ready availability for response during any disaster. But, MHA has been projecting the problem of shortage of manpower for IS duties, maintaining that the NDRF personnel withdrawn for law & order duties would be made available as and when there was any disaster.

Finally, in early 2007, the MHA agreed that NDRF would be a dedicated force meant for DR alone and directed the NDMA to send a proposal accordingly to frame the Rules for NDRF. A draft of the NDRF Rules was accordingly sent. Inquiries revealed that MHA had sent them to the Ministry of Law for Hindi translation and Gazette notification and that MHA had changed the draft rules mentioning that "at any point of time 50% of NDRF personnel may be deployed by the MHA for law & order duties". This change, if incorporated in the NDRF rules, would have been a catastrophe for this force, because in the normal course, 15–20% of the posts in the Forces remain vacant and 25–30% of the personnel are on leave or training. If MHA was authorised to divert 50% of the sanctioned posts, the actual availability of manpower in respective NDRF Bns would have been reduced to only 5–10% posts, and the force would have been no better than the Civil Defence or the Home Guards. It was a disturbing situation with the fate of the force in jeopardy.

In this situation, NDMA approached the then National Security Advisor (NSA), Shri M. K. Narayanan, to intervene. The Hon'ble Prime Minister (PM) convened a meeting of the NDMA on 25 October 2007 in which besides the NDMA Vice Chairman and Members, the Home Minister, the Finance Minister, Principal Secretary to the PM, the Home Secretary, and others were the invitees. NSA, not an invitee to the meeting originally, persuaded to participate. In that meeting, issues relating to NDRF were not discussed, it not being on the agenda. But, the NSA made a strong case for NDRF suggesting that it should be *a standalone-force* for DR on the lines of the National Security Guards (NSG). Further, he mentioned that the NDRF 'personnel should be on deputation to NDMA and would not form part of the MHA's general reserve as additional force for law & order situations.' The PM approved NSA's suggestion.

NSA's suggestion, however, was dropped from the minutes of the meeting on the ground that NSA was not an invitee. I approached NSA, and convinced him of the magnitude of the problem. Immediately, he issued a letter, which clinched the issue, leading to Gazette Notification of NDRF rules as a dedicated force on deputation to NDMA (on 14 February 2008). Needless to mention, that but for the active initiative of the NDMA and support of the NSA at crucial junctures in framing the NDRF rules, this Force would not have been what it is today.

5. DEPLOYING THE NDRF

Among the teething troubles in effective operationalisation of NDRF at the ground level in the initial years, was to carry conviction with the state governments to use that hitherto unknown Force in managing disasters. The states were used to requisitioning the services of the Armed Forces during disaster and continued with the practice.

Another significant development was that to preempt NDRF's deployment, at some places, the local units of Army started rushing their columns to the disaster sites, even they had not been requisitioned by the local authorities. To overcome that mindset of the State authorities, NDMA came up with two concepts. Firstly, 'pre-positioning' NDRF teams in sufficient numbers at likely disasters sites based on the weather forecast of the India Meteorological Department (IMD) was undertaken. Secondly, in the case of disasters with no advance warning, 'pro-active' deployment of NDRF teams at disaster sites with utmost promptitude without awaiting approval for deployment from NDMA or NDRF Hqr. A few other initiatives taken by the NDMA to acquaint the state and district authorities about the capabilities of NDRF included organising exhibitions and demonstrations by NDRF of its capabilities and resources mainly at state capitals and conducting community capacity building and awareness generation programmes relating to different disasters at district and block levels in states.

While such multi-pronged initiatives were on to ensure acceptability of NDRF by the states, a major challenge came in the shape of the breach of the Kosi River embankment near the Indo-Nepal border and the resultant massive flood in Bihar in August 2008. That flood could have led to huge devastation as there was no unit of NDRF in Bihar. But, as soon as the news was received, NDMA directed two nearby Bns at Kolkata and Mundali (near Bhubaneswar) to dispatch 13 motorised boats with 130 personnel, which reached the affected site with utmost promptitude the very next day (20 August 2008). Thereafter, for the next one week the skeleton team of officers in the NDMA remained in round the clock contact with the Bihar Government mobilizing motorised boats from the factory in Noida and personnel from different Bns and airlifting the same directly to Purnea. The limited resources of NDRF in this initial phase notwithstanding, as many as 175 motorised boats and around 1,700 personnel were mobilised by the NDMA and airlifted for deployment in the affected areas evacuating 1,05,000 affected people. But for that prompt and professional response from NDRF under the close guidance of NDMA, thousands of lives would have been lost. Impressed by the efforts of NDMA and NDRF, the Bihar Chief Minister (CM), Shri Nitish Kumar, wrote a complimentary letter to the PM requesting the sanction of a NDRF Bn for Bihar and offering land free of cost to NDRF at prime location near Patna. Taking a cue from this, the Andhra Pradesh CM, Shri Y. S. Rajsekhar Reddy, also wrote a letter with a similar request to the PM. The Government of India (GoI) sanctioned the two NDRF Bns as requested. Those letters brought the NDRF in to limelight. It has never looked backward since then...

6. STABILISING THE NDRF

While most of the major teething problems of NDRF in the first 2 to 3 years, issues equally important to effective operationalise of the force, like land and infrastructure for each of the Bns, training in handling different types of disasters including Chemical, Biological, Radiological and Nuclear (CBRN) emergencies, a state-of-the-art training institute in DR and staff for the NDRF Hqr, etc., were all sorted out to a reasonable degree of the satisfaction. A significant impediment in the planned growth of the force was difficulty faced in the matter of securing posting of a full-fledged DG NDRF. During 2006–2013, the DG (Civil Defence & Fire Services) was given the additional charge of DG (NDRF). Added to this was the problem of short tenures; as many as 13 DGs functioned during 2006–2013. The issue was sorted out finally with the down gradation of the post to the rank of an Additional DG and the posing of an Additional DG as DG NDRF in 2014. This has not only brought stability with a long term vision to the force, but has also changed the profile of NDRF significantly.

7. CLOSING COMMENTS…

As the founder Member of NDMA entrusted with responsibility of raising the force from scratch, it gives me immense satisfaction to see that NDRF has earned a name for itself for professionalism in handling disasters not only within the country, but also abroad. The commendable work done by it in the aftermath of the Fukushima nuclear leakage in the Great East Japan Earthquake in 2011 was a shining example of trans-national cooperation in DR and matter of great pride for NDRF in it's first international deployment. The painstaking and dedicated performance of the 40-member team of NDRF-India deployed in Onagawa, a port town of Miyagi Prefecture earned the team accolades from the then Prime Minister of Japan as also from a cross section of people of Japan, including Government officials, diplomats, media, the kin of victims, and the people at large.

It is encouraging to note that the NDRF has acquired a reputation for itself in the field of DR and is in great demand from all quarters in any natural or man-made disasters in the country. NDRF is poised now for higher trajectory growth. All this would not have been possible without the vision and support of Gen (Retd) N. C. Vij (Vice Chairman, NDMA) and Shri P. K. Mishra (Founder Secretary, NDMA), the timely intervention of the Shri M. K. Narayanan (former NSA), and the high level of commitment and dedication of the Commandants of NDRF Bns in the initial years… A host of officials in NDMA and NDRF HQrs put in efforts beyond the call of their duty to make NDRF a reality in which all can take pride.

S. N. Pradhan

NDRF as Systemic First Responder

Abstract: The deployment of NDRF, world's largest specialised disaster response force, is not an incidental task. It is the visible aspect of an integrated response of the disaster management mechanism in India, and signifies cross-cutting synergies between multiple governance layers and stakeholders from local to national levels. The ground level perspective of NDRF and its evolving role as a systemic first responder is critical to shaping the roadmap of a wholesome and robust disaster response ecosystem in India, involving all disaster-aware stakeholders (including local administration and community). Already, NDRF is engaged in multi-level capacity building, standardization and creating a culture of effective disaster communication.

Key words: Systemic response, Standardization, Multi-level capacity building, Strategic communication

1. INTRODUCTION

"*If I had to select one sentence to describe the state of the world, I would say we are in a world in which global challenges are more and more integrated, and the responses are more and more fragmented, and if this is not reversed, it's a recipe for disaster (all emphases added).*"

AntónioGuterres

United Nations Secretary-General, January 2019

The deployment of the National Disaster Response Force (NDRF) of India, in the context of a disaster situation**,** is not just the incidental tasking of perhaps the world's largest specialised disaster response force to attend to a certain type of disaster in a particular geography. It is the visible aspect of an integrated-as against fragmented-response of the disaster management mechanism of the Union and the State governments of India, working in tandem and often coordinated by nodal entities [NIDM, 2019]. It is more than just the act of deploying a force, in that it signifies cross-cutting synergies between multiple governance layers and stakeholders from the local to the national level. It also underscores that, while disaster management, in the first instance, is the mandate of the state governments, the central government is alert to its overarching responsibilities and ready for assistance during disasters. It has been spelt out by the Government of India in the following manner: while the primary responsibility of disaster management rests with the States, the Central Government supports the efforts of State Governments by providing logistical and financial support [MHA, 2020]. A National Disaster Management Plan (NDMP) is in order for a country like India, and hence very much in place [NDMA, 2019]. But, states as primary stakeholders are expected to develop their State Disaster Management Plans (SDMPs) from a sustainable risk-informed perspective and even calibrate their development plans and schemes in sync with the issues and priorities of SDMP including climate change, mitigation, inclusion, safety net for poor and disadvantaged, and gender sensitivity [CDKN, 2016]. Also, it indicates broad systemic alignment of diverse stakeholders ranging from the forecasting agencies, the nodal ministries and departments concerned, responder agencies both at the state and federal levels, district administrations, local governments and the communities themselves. The COVID-19 pandemic, as a public health disaster, has unambiguously highlighted and, to a great extent, demonstrated the imperative of a seamless coordinated response from all stakeholders, nationwide and indeed worldwide. Indeed, it signifies convergence of governance across borders while also extending into, and incorporating, the society itself [CRED, 2020]. All disasters and responses thereof, to a greater or smaller degree, offer the same lessons. The challenge posed by disasters cuts across compartments and warrants a coordinated response from stakeholders. Especially, in times of pandemics, the whole-of-society approach is a signal lesson for all disaster response efforts [USAID, 2011]. Therefore, each stakeholder's experiences and insights are important in attaining an evolved, integrated and effective template of disaster response. In this context, the perspective of agencies at the frontline of disaster response can be invaluable to shaping the integrated response template of a nation.

The perspective of NDRF as a frontline agency on the disaster response system is a perspective from the ground. While the question of improving the seamlessness and process dynamics of the system can always be open to debate, there is no doubt that the deployment of NDRF teams to any part within India or outside for rescue, relief or early recovery is the synergistic resultant of a 'same-page-decisional and operational-convergence' of multiple stakeholders across multiple levels. In short it is a systemic response, not one that can be compartmentalised and confined to the incident of mere deployment. This article on NDRF's role as a first responder is built on this systemic perspective.

2. THE MAKING OF THE NATIONAL DISASTER RESPONSE FORCE (NDRF) AS THE NATIONAL FIRST RESPONDER

Three back-to-back disasters in the space of five years, namely the Super Cyclone in Odisha (1999), the Bhuj Earthquake (2001), the Tsunami in Southern India (2004) were a wakeup call and a fast-learning curve for disaster governance in India. With more than 10,000 deaths and massive destruction in each, these natural disasters brought home the hitherto inadequate preparedness at the level of both policy and practice. The National Disaster Management (DM) Act, 2005 set up the disaster focused policy framework and set up the National Disaster Management Authority (NDMA) as the apex policy body in the country while prescribing a 3-tier structure down to the district level [MHA, 2005]. NDRF is also a creation of the Disaster Management Act, 2005 [NDMA, 2009]. Chapter VIII, Section 44(1) of the Act provides thus:

There shall be constituted a National Disaster Response Force for the *purpose of* ***specialist response*** *(emphases added) to a threatening disaster situation or disaster* [GOI, 2005].

The process of constituting the NDRF started in 2006 with conversion of 8 Battalions of Central Armed Police Forces (CAPFs). Presently, the force comprises of 12 Battalions, which are fully established and operational. 4 more recently sanctioned Battalions are in the process of being established. As can be surmised, NDRF is a force constituted essentially via deputation of personnel from the various CAPFs. It has no permanent cadre of its own. The deputation is for a period of 7 years after which the personnel return to their parent cadres. While there are arguments made for a partial or fully permanent cadre of NDRF this arrangement certainly has the merit of disseminating disaster response skill sets wider so as to be tapped as and when required. It is no secret that CAPFs are also deployed for disaster response when other resources fall short.

Besides being the largest specialised disaster response force in the world (in most countries the world over, including where large disaster response forces are available they are mostly fire service or civil defence personnel also undertaking disaster-response duties) NDRF is also unique in that each of its personnel is multi-skilled in rescue verticals like Medical First Response (MFR), Collapsed Structure Search & Rescue (CSSR), Flood Water Rescue (FWR), Chemical-Biological-Radiological-Nuclear rescue (CBRN) et al besides allied supplementary skills like deep-diving, heli-slithering , canine search & rescue etc.Each Battalion comprises of approximately 1150 personnel and is enabled with 310 specialised equipment to cater to the various rescue verticals. Each Battalion has 18 self-contained RESPONSE TEAMS of about 50 personnel each on the ready to move at a few minutes notice with all paraphernalia and logistics. NDRF**'s** equipment, work procedures and operational protocols and SOPs are derived from world standards and all in-house training regimes, which are intensive and frequent, adhere to these standards scrupulously [NDRF, 2020].

Besides the Battalion Headquarters, which are spread across the country there are also sub-battalion formations called Regional Response Centres (notified) and Temporary Tactical Locations

(TTLs) as long-term pre-deployments. Between the Battalions, RRCs and TTLs the NDRF has its presence and footprint in almost all states of India. With the raising and operationalisation of new Battalions the pan-India presence of NDRF will be further enhanced. The following table gives a breakup of the NDRF's pan-India presence.

This spatial distribution of NDRF units has a consequential impact on the quality of disaster response, ready availability in geographical proximity and ensures fast response time to developing disaster situations. On the other hand, it gives the state and district administrations the cushion of NDRF's proximate availability for appropriate deployment or pre-deployment. What is equally significant, is local availability of NDRF also facilitates capacity building of State and District Level first responders as well as the community at large.

3. SITUATING NDRF IN THE DISASTER RESPONSE MECHANISM IN INDIA

As per the INFORM Risk Index [IR, 2020], India figures in the high-risk category in terms of risk of humanitarian crises and disasters. While the risk factor displays a decreasing trend (probably owing to an increasingly responsive disaster management eco system across the India) the point of overall concern is that India continues to be in the high risk category in terms of multiplicity of hazards, both natural and man-made and its vulnerability to them [NDMA, 2020b]. The above clearly indicate that India as a nation will continue to be exposed to natural and man-made hazards. With a population in excess of 1.3 billion, rapid urbanisation and industrialisation, exposure to extreme weather events and vulnerability to disasters like floods, cyclones, earthquakes and industrial accidents- it all adds up to a formidable challenge to India's disaster response capabilities [SEEDS, 2019]. Response to disasters cannot be confined only to saving lives and property when disaster strikes. It will mean the entire gamut of systemic response from mitigation and preparedness to immediate response followed by recovery and reconstruction/ development. Indeed, response in this sense is predicated to the very nature and efficacy of governance and risk informed actions in both disaster and non-disaster times [UNDP, 2011].

Table 1: List of NDRF Battalions with Area of Responsibility (AOR)

BN NDRF	Name of Battalion	Name of States and UTs in AOR
1	Guwahati Assam	Assam (24 Districts), Meghalaya, Mizoram, and Tripura
2	Nadia West Bengal	Sikkim, and West Bengal
3	Mundali Odisha	Odisha, and Chhattisgarh
4	Arakkonam Tamil Nadu	Andman & Nicobar Islands, Kerala, Lakshadweep, Puducherry, and Tamil Nadu
5	Pune Maharashtra	Goa, Maharashtra
6	Vadodara Gujarat	Daman & Diu, Dadar& Nagar Haveli, Gujarat, and Rajasthan,
7	Bhatinda Punjab	Chandigarh, Himachal Pradesh, Punjab, Jammu & Kashmir, and Ladakh
8	Ghaziabad Uttar Pradesh	Delhi, Haryana, Uttarakhand, and Uttar Pradesh (18 Districts)
9	Bihta Bihar	Bihar, and Jharkhand
10	Vijayawada Andhra Pradesh	Andhra Pradesh, Telangana, and Karnataka
11	Varanasi Uttar Pradesh	Madhya Pradesh, and Uttar Pradesh (57 Districts)
12	Doimukh Arunachal Pradesh	Assam (09 Districts), Arunachal Pradesh, Manipur, and Nagaland

The NDRF as the largest specialised and dedicated disaster response force in the world is exposed to a wide range of disaster situations nationwide. Given India's multiple disaster vulnerabilities, NDRF has seen and often led the response from close quarters and has ringside insights into processes and resultants of effective or not-so effective responses. In India, while the function of disaster response is in the domain of State Government (and consequently district and local Governments), the federal government has an overarching role and jurisdiction and often assists and facilitates the state governments in crisis management. As a part of this mechanism, NDRF is often pressed into service as a federal force of assistance [VIF, 2016]. The experience of disaster response for more than a decade leads to the conclusion that the NDRF has been increasingly called upon to operate as the first responder and often lead the same. On the testimony of past experience of disasters in India, NDRF as a federal first responder will continue to play a critical role in disaster response across India. The desirability and the demands under cooperative federalism will only enhance this role. But it is essential that state and local district response mechanism are comprehensively established and strengthened as a conscious governance endeavour of rendering it a part of the systemic response. There is need to look at disaster response as fundamental to mainstream governance in the states. There also seems to be an urgent necessity of establishment and institutionalisation of dedicated first responder agencies in every state and also disaster response capacity building, local Police, Home Guard, Civil Defence, Fire Services as well as setting up of volunteer mechanism at the village and Panchayat level. With the national ecosystem in place there is an urgent need to establish and strengthen the sub-national first response mechanisms across India with focus on state and local level capacity building [VIF, 2016].

Some of the glaring weaknesses are worth considering. The first comprises the obvious inconsistencies and non-uniformity of disaster response institutions across India. While most states situate disaster management as a subject within the mandate of the Home Department, in several states the subject is with the Department of Relief. The formal architecture still may not come in the way of functioning efficiently but for the fact that preparedness for disasters is not often taken as a mainstream governance duty. In states which historically have had to face serious damage to life and property in the past, there are tangible policy and institutional steps taken to address the disaster management agenda. Such states have invested in disaster resilience capacities as well as awareness generation, training and empowerment of all stakeholders, apart from setting up a full-fledge-947115221 d disaster response mechanism. For example, Gujarat and Odisha have been early movers, and set up their institutional architecture even before the enactment of DM Act. 2005. Odisha set up its Disaster Control Room or Emergency Operations Centre (EOC) as well as established its own SDRF (christened- ODRAF or the Odisha Disaster Response Action Force) well before NDRF itself was established. While most states in India now have departments of disaster management to speak of, many states still have inefficient EOCs and perfunctory SDRFs [VIF, 2017]. Clearly, there is a lack of will in several states, which appear to regard disaster management, and adequate and sustained preparation for disaster response. as low priority issues. Unless there is a governance culture of disaster preparedness things will not change on ground and, what is more, the community cannot be expected to be disaster ready.

In contrast, it must be said that the Union Government has been highly focused on prioritising disaster response as a critical facet of good governance. The Prime Minister in his capacity as Chairperson of the NDMA, the Union Home Minister as administrative Minister of the disaster management portfolio, the Cabinet Secretary as Chairperson of the National Crisis Management Committee and the Union Home Secretary in his capacity as head of the National Executive Committee (NEC) have been increasingly proactive in taking the initiative to systemically anticipate and assess disaster-risk and subsequently respond to the threats in a robust manner. This has had a direct impact on the readiness and availability of NDRF to states in their bid to tackle emergent situations. As can be inferred, the states which are more disaster oriented have worked strongly, and effectively, in tandem with the Union Government and its agencies like NDRF. Others which are ill prepared have not been able to provide as effective a response as prepared states, in terms of saving of life and property. In the absence of uniform systemic preparations and approach at the state, and consequently, the district levels, the consequential burden on NDRF has multiplied. Naturally, this has had its impact on the sustained efficacy of the NDRF itself.

4. ENHANCING THE SYSTEMIC ROLE OF NDRF: ROADMAP FOR MULTI-STAKEHOLDER OUTREACH AND STANDARDISATION

NDRF has been envisaged as the National 126628703 Agency for disaster response. While it is understood that onus of disaster response lies primarily with the State Governments (including their district administrations) NDRF is pressed into service as the '*force of assistance*' to the State and district level responder. In an ideal situation, NDRF should be playing the role of the specialist disaster response force. This is what is expressly enshrined in DM Act (2005). But, in reality it has transpired that NDRF has been regularly**,** and often routinely**,** requisitioned and utilised even for incidents like drownings, bore-well incidents, and small-scale building collapses. This is a reflection on state and district level disaster preparedness even at basic levels and certainly is food for thought for all stakeholders. How can this change? The simple answer is**,** by building sustained capacity at sub-national levels, *i.e.,* state, district and the local community.

The oft-stated and settled paradigm of disaster response is that resilient community and an empowered and resilient local administration is the best bulwark of disaster response. The Report of the Task Force that submitted its report on review of the DM Act, 2005 recommended the formal incorporation of the duties, responsibilities and role of citizens and the community including mentioning of their rights. Also, it has recommended inclusion of community-based disaster preparedness with the provisions relating to local authorities [MHA, 2013]. Such a recommendation notwithstanding, in India disaster response, is not yet strongly and uniformly perceived and accepted by State District and local Governments as a part and parcel of mainstream governance. There is a glaring lack of uniformity and consistency in the disaster response eco-systems across the States and Union Territories. A good parameter of comparison can be the availability of State Disaster Response Forces (SDRF),constitution of which has been recommended under National Policy on Disaster Management, 2009 [NDMA, 2009]. As per Section 3.4.5 of the Policy, the State Governments are required to raise their own SDRF for quickly responding to disasters. 26 states have issued gazette notifications regarding the establishment of SDRFs. Nonetheless, only in 11 states SDRFs are functional as a self-contained disaster focused unit. What is a matter of concern is that many of SDRFs are functioning sub-optimally in term of their disaster response capabilities as well as knowledge, skills and attitude towards disaster response [VIF, 2017].

The ideal configuration of the disaster response mechanism in the country like India must necessarily be one of multi-level capacity from the local self-government including panchayat and municipalities up to the level of national government. There will need to be a basic threshold level preparation and capabilities for disaster response at each level. The NDMA has in its extant guidelines recommended an Incident Command System (ICS) template at all levels from the national to the district and local levels [NDMA, 2010]. Countries like China and Russia have augmented their local capabilities to the point where functionaries at village and municipal level are trained and empowered with knowledge, skill and aptitude of an active first responder. In other developed countries, like the United States and the European nations, community level volunteers are in place to provide response in the first few hours of disaster. This orientation at community level engenders a culture of coordinated multi-level disaster preparedness and as such is probably the most critical level of preparedness. In India disaster preparedness at the community level is still at best minimal. While in some states, like Odisha, Andhra Pradesh, Tamil Nadu, Assam, and Bihar, there is high level of awareness in the community to comply with government directives issued from time to time specially for evacuation, mock drills, etc., the culture of being disaster-ready is far from uniform. Similarly, at the district and state levels, there is perceptible inconsistency in preparedness against disasters. While formal disaster management architecture comprising institutions such as the State Disaster Management Authorities (SDMAs) and District Disaster Management Authorities (DDMAs) is in place, what is conspicuously lacking in several states, is the priority given to the disaster governance and coordinated response mechanisms and the will to treat it as a critical feature of mainstream governance and assign to it the amount of seriousness that it merits [CDKN, 2016]. As pointed out earlier in this article, at the national level, there is an increasing amount of seriousness being attached to disaster governance. There is no doubt that, in recent times, Government of India has accorded the function of disaster management the seriousness it deserves. The proactive approach taken by the Government of India over the years should be a welcome encouragement for states to synergise with the efforts and initiatives taken at the Government of India level. All the Ministries and Departments of the Government of India are duty-bound to put in place their own disaster management plans depending on their nodal responsibilities. Also, the apex legislature has made it unequivocally clear that all ministries should take adequate and comprehensive steps from the disaster response perspective, while even suggesting desirable steps from critical ministries like Ministry of Health and Ministry of Water Resources [PAC, 2015]. Also, this encourages the spirit of co-operative federalism. The operational outreach of the NDRF has certainly strengthened as a fall out of the Union Government's efforts. It will not to be overstating the case to say that today deployment of NDRF to any state or states is the most visible arm of national response to a disaster situation. It is indeed regarded as a welcome intervention of the Government of India. With sustained local capacity building, the efficacy of disaster handling across the disaster cycle could be multiplied manifold [UNDRR, 2019].

In the context of multi-level capacity building roadmap for disaster response in India, the NDRF can play a seminal role. NDRF can utilise its pan-India presence and footprint in all states to closely handhold the process of all-round capacity building training and awareness from the village level to the district and state level stake holders. In the year 2019, NDRF held nearly 100 mock drills involving, public sector undertakings (PSUs), State Governments, Para-military Forces, State Police, Home Guards, Fire Services etc. Similarly, NDRF trained Nehru Yuva Kendras (NYKs) volunteers in close collaboration with the Ministry of Youth Affairs, so as to make them effective first responders in the event of any disaster (small and big) in their local area. Such trained volunteers were given the nominal title of *NDRF-friends*, so that given the occurrence of actual disaster they could act as facilitators to assist the NDRF or other disaster response forces [TOI, 2019]. The Prime Minister**,** in his address from the ramparts of the Red Fort recently**,** advocated the need to train the National Cadet Corps as disaster first responders. NDRF regularly conducted Familiarisation Exercises (FAMEX), Community Awareness Programs (CAP), School Safety Programs (SSP)through which thousands of community members including students are skilled and empowered as first responders in disaster situations. The NDRF mock drills in coordination with National Disaster Management Authority (NDMA) and State Governments are one of the most practical and effective ways of disaster preparedness at cutting edge level [NDRF, 2020]. Table (Table 2) summarises the system-wide work that NDRF does and can scale up not only for strengthening response, but also for the prevention/mitigation, preparedness and recovery phases of disaster management.

For the foreseeable future, already NDRF is working on a plan to address national level preparedness as well as the requirements of being available as a specialist response force for international disaster response commitments. One of the differentiating concepts here is standardisation of processes of protocols both for national and international level commitments. At the national level, there is a strong case for standardising the SOPs for first responders in the context of different typologies of disaster. Given the fact that apart from natural disaster, biological disasters (such as the COVID 19 pandemic), chemical and natural disasters (such as the Visakhapatnam gas leak), as well as nuclear, radiological and explosives disasters – all will become more and more probable with rapid urbanisation and industrialization, as well as tapping of nuclear power for energy. It will be contingent upon a country such as India, to take in the *all-hazard approach* into its systemic preparedness. Such preparedness cannot be ensured without standard protocols and SOPs. What is more, such protocols should ideally be comparable to their international counterparts.

Table 2: System-wide Role of NDRF

IMPENDING DISASTER SITUATION	**DISASTER SITUATION (in addition to continuing with all actions in impending disaster)**	**NON-DISASTER SITUATION**
Coordination with forecast agencies	Human Rescue	Mock Drills with other stakeholder agencies including community
Coordination with State Government	Livestock Rescue	Familiarisiation Exercises
Coordination with District and Local Administration	Assist in Relief including medical camps	Community Awareness Programs
Coordination with State First Responders, like SDRF, Police, Home Guards, Civil Defence, and Fire Services	Assist in immediate Recovery efforts	Capacity Building/Training of other first responders, like SDRFs, Police, and Civil Defence
Coordination with Central Ministries and Departments	Coordination with Armed Forces, State Operations Centre (especially Air Force for emergency airlifting)	Customised first responder trainings - School/college Safety programs - NCC, NSS, Scouts & Guides
Coordination with other agencies, like the CAPFs and Armed Forces	Media Management	Special Campaigns

NDRF in consultation with NDMA has already initiated the process of standardising as per International *Search and Rescue Advisory Group (INSARAG) / United Nations Office for the Coordination* *of Humanitarian Affairs (UNOCHA)* guidelines. Under such a regimen, scope of standardisation once achieved will include disaster response SOPs, protocols of operation and training, equipment standards for rescue relief and allied activities, etc. The above move also conforms to the aspirational agenda of disaster risk reduction under the Prime Minister's ten-pointprogramme, wherein one of the commitments is international co-operation and assistance in disaster response [NDMA, 202a]. The deployment of the NDRF teams during the triple disaster in Japan in 2011 and for the earthquake in Nepal 2015, did not only earne encomia for India but also strengthened India's humanitarian profile. This can be seen as an important part of soft diplomacy. Recently NDRF organised, under the aegis of the Ministry of External affairs, dispatch of relief material to flood effected areas of Nepal, Cambodia, and also to Beirut in Lebanon, where there had been devastation due to blast in explosive godowns.

In sum, it can be said that the NDRF, in many senses, is an important vehicle of promoting the culture of disaster preparedness across various levels and involving various stake holders. Of course, it cannot pretend to be the only source of capacity building and facilitation. But, it can be a credible triggering force in a cascading process of all-round awareness and practical readiness. As shown above, by standardising processes and protocols, NDRF can become a platform also for standardisation for other state and local level disaster responders. Further, it can utilise its own certified and standardised teams for humanitarian outreach and assistance to other countries facing disaster situations. Such developments will endorse the approach of systemic disaster-risk assessment and systemic response of the country and go on to add value and credibility to the disaster response template of India.

5. NDRF AND MEDIA PLATFORMS: STRATEGIC DISASTER COMMUNICATION AS A PART OF SYSTEMIC RESPONSE

Digital and networked technology urges systemic response not only within a country but on a world scale. The response of the world to the COVI19 pandemic has, at least in terms of sharing of information, unified the world. Across the world, more and more countries are using smart digital technologies to enhance efficiency of disaster management. Such technologies are often networked and autonomous and can communicate and analyse data to facilitate informed decision and action towards disaster resilience. As a result, they also work across systems and stakeholders and encourage integrated responses.

Traditional and sophisticated technologies help disaster communication and response ranging from Collapse Structure Search and Rescue (CSSR) equipment, Flood Rescue Equipment and Wireless Communication equipment, etc. In the digital age with the advent of the Fourth Industrial Revolution or 'Industry 4.0', the technologies that are becoming relevant are Big Data Analytics, Internet of Things (IOT), Robotics, Artificial Intelligence, and 3D Printing [ITU, 2019]**.** Already mobile communication technology and social media is proving to be a great enabler in disaster management related communication. The use of Satellite, Unmanned Aerial Vehicle (UAV), Drone, *etc.,* is multiplying also. Yet, it must be said that in India, we have still a long way to go in leveraging and scaling all such new age technologies optimally for disaster response. But there are enough bright spots to suggest the way forward in disaster response system building.

One of the bright indicators of use of new age technologies, is the much-improved prediction/forecasting services based on satellite generated data as well as sensor generated data. These sources have been intensively utilised with the help of data analytics and high level computing, to arrive at accurate prediction vis-à-vis natural disasters, like cyclone, heavy rains, and floods [UNESCAP, 2019]. It is heartening to note that stakeholders, like the Department of Earth Sciences and constituent units under it (like the India Meteorological Department (IMD), Central Water Commission (CWC), Geological Survey of India (GSI) are able to exploit best in world class technologies to provide high quality forecasting and prediction. At the time of writing this article, there is an interesting development announced by the IMD about the formal launch of *dynamic impact-based-cyclone forecasting* to facilitate response agencies, like NDRF. The new system will have location or district-specific tailored warning mechanisms, factoring in the local population, infrastructure, settlements, land use and other relevant elements. All disaster management agencies will make extensive use of cartographic, geological and district-wise hydrological data under this mechanism [MOES, 2020].

Impact based forecasts have been already been tried and provided from time to time during the cyclone 'Fani' in 2019 and Super Cyclone 'Amphan' and Cyclone 'Nisarga' in 2020 have earned worldwide appreciation for being decisive factors in successfully handling these disasters. What is more important, such predictions facilitate saving of life and property on a large scale, thus adding to the disaster preparedness quotient of the nation. The NDRF utilised these predictive services to take preventive actions, like evacuation and awareness drives to save lives and minimise damage to property. In COVID times, when NDRF faced the double challenge of floods or cyclones, it was the accuracy of predictions that helped it optimise on rescue and relief efforts while preparing for the long term.

Apart from the predictive technologies which are helping effective and systemwide preparedness, the other aspect of digital technology is helping integrate disaster response in the communication technologies that have made the reach of electronic media and social media ubiquitous. The total reach of electronic media has made the citizen both a witness and participant in disaster response. This phenomenon has been multiplied in manifold ways in the domain of social media. It is well known that social media has become an integral part of community life and is proving to be a game changer for disaster communication. Combined with the phenomenon of crowd-sourced information from the citizen themselves, social media platforms can become much valued and important source of information, provided appropriate measures are ensured to keep the information authentic. A recent study points out that major data source for disaster response today are satellite data, social media data, crowd sourcing, sensor web and IOT, and mobile GPS and CDR. In that order of utilisation, it is worth remembering that major disaster in India (like Kerala flood in 2018, Chennai flood, Super Cyclone 'Amphan', Cyclone 'Fani') have witnessed intensive use of social medial platforms, like Twitter and Facebook, as well as use of mass messaging - all of which were sourced to facilitate both individual and institutional communication [UNISDR, 2017].

The National Disaster Response Force is both user and beneficiary of new age technologies and developments. It widely leverages social medial platforms for disaster communication. Recently, for example, NDRF tied-up with Twitter to ensure setting-up search-prompt related to disasters so that all disaster related searches can be directed to authentic information sources, including the NDRF handles [TOI, 2020]. Similarly, the NDRF regularly leverages satellite technologies, crowd sourcing, etc. in its disaster response efforts. What is significant is the collaborative mechanism in place with prediction and forecasting bodies (like IMD, CWC, GSI, Indian National Centre for Ocean Information Services (INCOIS), and Snow and Avalanches Study Establishment (SASE)). The inputs from these predictive agencies, because of their timeliness and accuracy are in the form of 'Climate and Disaster Intelligence' which serve as lifeline and actionable inputs for the NDRF. Some of the technologies that NDRF itself uses-ranging from satellites, to sensors, to autonomous communication systems and of course the electronic and social media platforms have proven to be the ideal systemic response integrators. Such technologies, in the context of disaster management have the singular merit of providing ONE VERSION OF TRUTH if given from an authorised source or sources. The information about disaster response generated from the ground and often in real time by NDRF teams serve to give the anxious nation an authentic and reliable version of the 'truth'. This was illustrated rather tellingly during the Visakhapatnam Gas Leak incident recently, where there was media fanned speculation in the country about a possible second Bhopal type tragedy. It took real time visuals from NDRF teams in Visakhapatnam along with a strategically timed press meet with the national media to set the wild speculations at rest. This was systemic and strategic communication at its possible best. Media, both social and electronic, make this integral approach possible thus strengthening disaster response. NDRF has tried and aims to further improve in leveraging media platforms most effectively as a part and parcel of strategic communication and systemic disaster response.

6. CONCLUSION

Increasingly, the world over there is growing realisation of the need for a whole-of-the-society and all-of-government approach to disaster preparedness and response [IFRC, 2016]. NDRF as federal first responder can function best as an integral part of this ecosystem with a sustained agenda of action and partnership with other stakeholders through both disaster situations and normal times. In other words, when not operating in disaster situations, NDRF should be empowering, building capacity, enabling outreach and extension services as well as cross cutting collaborations with other stakeholders. This paper puts forth the hypothesis that '*siloisation*' of NDRF or for that matter any first responder in context of disasters as 'last resort emergency responders' is restrictive & dysfunctional. It makes a case for the imperative need to see frontline disaster response as a continuum wherein critical first responders like NDRF are essentially systemic responders who are not only easily identifiable and visible arm of the disaster response ecosystem but also an entity that function as cutting-edge enablers of a culture of disaster readiness. The entire gamut of actions from operations, to extension, empowerment and capacity building efforts to assimilation of best practices, protocols, tools and technologies and strategic disaster communications by leveraging electronic and digital media platforms- all should be seen as convergence and culmination of processes that are aimed towards disaster preparedness and resilience at scale. The efforts to standardise and also internationalise the NDRF's role is not so much a solo NDRF exercise as a national systemic extension of India's disaster response mechanism as such. Each player's roadmap in this disaster response ecosystem is expected to be in sync with the roadmap of the ecosystem itself. At least this seems to be the lesson emanating from the cumulative body of disaster management experience, including the experience from the COVID19 pandemic.

The UNDRR Global Assessment of Risk report of 2019 talks emphatically about how risks in the era of climate change are nonlinear and cascading in impact. In the face of this, departmental compartmentalisation at governance level can be a crucial error. It states further, "While it can be practical to categorise risks so that we can delegate responsibility to different organisations, institutions or individuals, we need to incentivisetrans-disciplinary integrated, multi-sectoral risk assessment and decision-making to improve efficiency, reduce duplication of effort and allow for connected, collective action. This is particularly critical at national government level. Risk must not be departmentalised. National planning bodies with representation from all sectors must be convened to develop national disaster risk reduction strategies that assume an all-of-State institutions approach to risk reduction" [GAR, 2019].

NDRF as a critical cog in the disaster response mechanism of India strives to align and dovetail its own vision, mission and action with the collective national agenda and roadmap of disaster risk reduction. It is from this lens of systemic response that this article describes and analyses NDRF, its present work profile and future roadmap.

References

1. CDKN, (2016), Climate Development Knowledge Network (CDKN), Overseas Development Institute (ODI) &All India Disaster Management Institute (AIDMI)

   https://cdkn.org/wp-content/uploads/2016/07/India-disaster-management-web.pdf

   Accessed on 5 November 2020

2. CRED, (2020), Natural Disasters 2019 - Now is the Time to not Give Up, Centre for Research on the Epidemiology of Disasters (CRED)

   https://cred.be/downloadFile.php?file=sites/default/files/adsr_2019.pdf

   Accessed on 5 November 2020

3. GAR, (2019), The 2019 Global Assessment Report on Disaster Risk Reduction, United Nations office for Disaster Risk Reduction (UNDRR)

   https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2019

   Accessed on 5 November 2020

4. GOI, (2005), *The Disaster Management Act, 2005*, Gazette of India, Ministry of Law and Justice, Government of India

www.ndma.gov.in/ images/ndma-pdf/DM_act2005.pdf

Accessed on 5 November 2020

5. IFRC, (2016) Whole of Society Approach, International Federation of Red Cross & Red Cresecent Societies

https://media.ifrc.org/wp-content/uploads/sites/5/2017/10/Small-Business-CP3-1-pager.pdf

Accessed on 5 November 2020

6. IR, (2020), INFORM REPORT 2020, Shared evidence for managing crises and disasters

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC120275/01_inform_2020_online_%284%29.pdf

Accessed on 5 November 2020

7. ITU, (2019), Disruptive technologies and their use in disaster risk reduction, and management, International Telecommunications Union (ITU)

https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Documents/2019/GET_2019/Disruptive-Technologies.pdf

Accessed on 5 November 2020

8. MHA, (2005), Disaster Management in India, Ministry of Home Affairs, Government of India

https://www.unisdr.org/2005/mdgs-drr/national-reports/India-report.pdf

Accessed on 5 November 2020

9. MHA, (2013), Report of the task force: a review of the Disaster Management Act 2005 , Ministry of Home Affairs, Government of India

http://ndmindia.nic. in/Rpt_TaskForce_300913.pdf

Accessed on 5 November 2020

10. MHA, (2020), Responsibilities, Disaster Management Division, Ministry of Home Affairs,

https://www.ndmindia.nic.in/responsibilities

Accessed on 5 November 2020

11. MOES, (2020),

https://vigyanprasar.gov.in/wp-content/uploads/Vigyan-Samachar-MoES-News-1-13-October-20.pdf

Accessed on 5 November 2020

12. NDMA, (2009), National Policy on Disaster Management, National Disaster Management Authority website

    https://ndma.gov.in/images/guidelines/national-dm-policy2009.pdf.

    Accessed on 5 November 2020

13. NDMA, (2010), National Disaster Management Guidelines Incident Response System, National Disaster Management Authority

    https://ndma.gov.in/images/guidelines/incidentresponsesystemjuly.pdf

    Accessed on 5 November 2020

14. NDMA, (2019), National Disaster Management Plan, National Disaster Management Authority

    https://ndma.gov.in/images/policyplan/dmplan/ndmp-2019.pdf

    Accessed on 5 November 2020

15. NDMA, (2020a), Prime Minister's 10 Point Agenda on Disaster Risk Reduction, National Disaster Management Authority website

    *https://ndma.gov.in/en/media-public-awareness/pm-10-points-agenda-on-*drr.html

    Accessed on 5 November 2020

16. NDMA, (2020b), Vulnerability Profile of India, National Disaster Management Authority

    https://ndma.gov.in/en/vulnerability-profile-of-india.html

    Accessed on 5 November 2020

17. NDRF, (2020), Web Portal of the National Disaster Response Force

    http://www.ndrf.gov.in

    Accessed on 5 November 2020

18. NIDM, (2019), *Handbook on Disaster Management for Nodal Officers (Compilation)*, National Institute of Disaster Management, Ministry of Home Affairs, Government of India

19. PAC, (2015-16), *Twenty Fifth Report of the Public Accounts Committee onDisaster Preparedness in India*, Lok Sabha Secretariat, New Delhi

20. SEEDS, (2019), *The Face of Disasters 2019, Beyond Response to Build a Sustainable Future*, Report of Sustainable Environment and Ecological Development Societ

21. TOI (2019), NDRF Begins Training Youths to help People During Disaster

    https://timesofindia.indiatimes.com/city/bhubaneswar/ndrf-begins-training-youths-to-help-people-during-disaster/articleshow/70950121.cms

Accessed on 5 November 2020

22. TOI (2020), With NDRF Twitter Launches Search Prompt for Disaster Management and Emergencies

    https://timesofindia.indiatimes.com/india/articleshow/76979520.cms

    Accessed on 5 November 2020

23. UNESCAP, (2019), Asia Pacific Disaster Report

    https://www.unescap.org/publications/asia-pacific-disaster-report-2019

    Accessed on 5 November 2020

24. USAID, (2011), Beyond Pandemics: A Whole of Society Approach to Disaster Preparedness

    https://reliefweb.int/sites/reliefweb.int/files/resources/Full_Report_2400.pdf

    Accessed on 5 November 2020

25. UNDP, (2011), Disaster Management in India

    https://www.undp.org/content/dam/india/docs/disaster_management_in_india.pdf

    Accessed on 5 November 2020

26. UNDRR, (2019), Words into Action guidelines: Developing national disaster risk reduction strategies

    https://www.undrr.org/publication/words-action-guidelines-developing-national-disaster-risk-reduction-strategies

    Accessed on 5 November 2020

27. UNISDR(2017), Public Communication for Disaster Risk Reduction,

    https://www.preventionweb.net/files/52828_apubliccommunication[1].pdf

    Accessed on 5 November 2020

28. VIF, (2016), Revisiting India's Disaster Response Mechanism: Challenges and Way Forward

    https://www.vifindia.org/sites/default/files/revisiting-india-s-disaster-response-mechanism-challenges-and-way-forward.pdf

    Accessed on 5 November 2020

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Disaster Management: Incident Response System

Abstract: This paper presents a detailed overview of the Incident Response System (IRS), starting with its need, the methodology of how it was arrived at and its significance. The primary management functions are elaborated which include overall responsibility, command, operations, planning and logistics. Also, the composition and role of the Incident Response Teams is discussed. How the IRS is triggered (with or without early warning) and the community participation are clarified. The features of IRS are elaborated – including management by objective, the incident action plan, organisational flexibility, span of control, multi tasking, personnel accountability, resource management and common terminology. The paper closes with details of command and control, namely transfer of command, unity and chain of command, integrated communication and unified command.

Key words: Incident Response System, Disaster Management, Incident response teams, mock exercises, command and control, functions.

1. BACKGROUND

The Incident Command System (ICS) evolved in the USA and later Indian personnel were trained in it by the USAID. A number of administrators were sent to USA for training and a number of them were trained in India by US expert and Indian experts who had already been trained. The Government of India decided to introduce the Incident Command System (ICS) to adopt the world's best practices in Disaster Management (DM).

When the NDMA was formed and it looked at the Incident Command System, it was immediately clear that there was a need to integrate the system seamlessly with the Indian administrative structure. It was realized that the ICS was conceived keeping in mind the American administrative set-up, its society, its requirement and its own capabilities in mind. But, in India the administrative structure was different and the society was also not clearly integrated in the response mechanism. Also, the Indian capabilities were different. It was not clear as to how every department of the Government and its members could be integrated in the response mechanism without affecting their own chain of command and their own responsibilities. Further, it was found that most of the people who had been trained in India and abroad had were transferred from those postings and were not available in the districts where disasters had taken pace. Therefore, there was a requirement that everyone in the district and at the state headquarters were made conversant and fully aware of their responsibilities in disaster management. An Incident Response System (IRS) integrating everyone needed to be put in place.

The then Vice Chairman of NDMA, Gen. N. C. Vij, gave me the responsibility to work out a strategy and guidelines to institutionalize the response mechanism in the country. His intention was to incorporate this system in the National Plan and ensure that the State Government should also introduce it in their State and District Disaster Management Plan.

1.1 Need for IRS

It was observed that in the then existing system there was lack of:

(1) Accountability because of the ad-hoc and emergent nature of arrangements and no prior training for effective performance;

(2) An orderly and systematic planning process;

(3) A **c**lear chain of command and supervision of response activities;

(4) Proper communication regarding the response activities, between

different sections, inefficient use of available resources, use of unclear phrases and terminology and no prior communication plan so that functionaries could be in touch with each other's needs and problems;

(5) A pre-determined method/system to effectively integrate inter-agency requirements into the disaster management structures and planning process;

(6) Coordination between the first responders and individuals, professionals and NGOs with specialized skills during the response; and planning phase; and

(7) Use of common terminology for different resources resulting in improper requisitioning and inappropriate resource mobilization, *etc*.

1.2 Methodology

Keeping in mind India's own administrative structure with some variations between them in a few states, its own requirements, its own capabilities, and the fact that the community needed to be integrated in the whole process, a formalized response management structure/ system was absolutely necessary. Considering the above factors, it was ensured that the guidelines meet the requirements of each state. For this purpose four regional consultation workshops were held, in which it was ensured that each state participates and give their inputs. Apart from this, a number of focused group discussions were also held in which officers and experts who had already been trained in ICS earlier also participated. It was in this process that a number of organizational requirements were added like the use of Railways, Road and water transport, how to immediately organize Air support if required. These had not at all been elaborated in the American ICS. It was because of these unique requirements and changes that a new name for the concept was introduced in order to differentiate between the *American ICS* and *India's IRS*. The basic concepts of the ICS were fully incorporated in the IRS.

1.3 Significance

The IRS envisages and lays down various tasks that may need to be performed by the existing administrative machinery at various levels. Also, it recommends prior identification of Officers for the performance of different tasks and getting them trained in their respective roles, and provides a structure under which all the line Departments can function in tandem with the district and state administration. Some of the significant features are:

(1) Pre-determined teams in which each member knows his role and responsibilities;

(2) Systematic and complete planning process;

(3) System for accountability for the IRT members;

(4) Clear cut chain of command;

(5) Effective resource management;

(6) Proper and coordinated communication system;

(7) System for effectively integrating independent agencies in to the planning and command structure without infringing on the independence of the concerned agencies;

(8) Integration of community resources in the response;

(9) Incident Response Team (IRT) activated automatically at the first sign of danger;

(10) Efficient way of functioning;

(11) Integrates the smallest level of administration right up to the Government of India and has smooth procedures of enlarging the IRT as and when required with a clear cut chain of command;

(12) Instantly integrates the community right from the block level;

(13) Gets activated both in case of disasters with early warning and those without any warning; and

(14) Integrates the different departments of the government, who may be having their own responsibilities in the matter into one response team through the concept of Unified Command.

2. WHAT IS IRS?

The Incident Response System (IRS) is an effective mechanism for reducing the scope for ad-hoc measures in response by organizing various levels of state administration (State, District Sub-division and Block) in to IRT. It incorporates all the tasks that may have to be performed during disaster response management irrespective of their level of complexity. Also, it envisages a composite team with various sections to attend to all the possible response requirements. The IRS identifies and designates officers to perform various duties and get them trained in their respective roles. After training in IRS, the stakeholders will be aware of their roles at various positions of IRT, which will be manned by them. It helps immensely in reducing chaos and confusion during the response phase. Everyone will know: what needs to be done, who will do what, who is in command, *etc*. A standing order should be passed both at the state and district levels in this regard, clearly indicating the responsibilities of the Officers and their positions in the IRT.

The guidelines on IRS should be available to everyone and they should function as a "Blue Book" for disaster response and its management. The Responsible Officer - District Magistrate (RO) has been authorized in case of an exigency to make additions in the duties of different individual Officers by multi-tasking and/ or adding the responsibility of the other functions. This should preferably be done only in exigencies and not normally. IRS is a flexible system and all the Sections, Branches and Units need not be activated at the same time. Various sections, branches and units need to be activated only as and when they are required. Only the Emergency Operation Centre (EOC) should be functioning always (24×7).

3. PRIMARY MANAGEMENT FUNCTIONS

3.1 Overall Responsibility

RO (Responsible Officer): The District Magistrate has been designated as the RO and has the overall responsibility for the smooth and effective disaster response as per IRS. He has not been designated purposely as the Incident Commander as he has to attend to a lot of other duties during that period. This does not mean that he is absolved of the overall responsibility. He has to ensure that his IRTs are adequately manned and function properly.

3.2 Command

Incident Commander (IC): The IC is responsible for management of response activity in his / her jurisdiction.

3.3 Operations

The Operations Section is responsible for directing the tactical actions to meet incident objectives as per the Incident Action Plan.

3.4 Planning

The Planning Section is responsible for the collection, evaluation, and display of incident information, maintaining status of resources, and preparing the Incident Action Plan, incident-related documentation, etc.

3.5 Logistics

The Logistics Section is responsible for providing adequate services and support to meet all incident or event needs as per the *Incident Action Plan (IAP)*. Apart from Support and Service branches, Finance also is a branch in the Logistics Section. The Finance Branch is responsible for keeping track of incident-related costs, personnel and equipment records, administering procurement contracts associated with the disaster or event and expedite the release of Ex-gratia payments, etc. This function is of utmost importance and has been specially introduced in the logistic system, because in the past, a number of cases were reported in different disasters, in which Financial Rules of the Government were not followed and records not maintained properly, as result of which many senior Officers faced various charges. Maintaining proper record of every financial transaction is of utmost importance. It is the responsibility of the finance person to keep track of expenditure, obtain orders of the Competent Authority in all urgency and keep the RO and Incident Commander aware, literally on a daily basis.

Apart from the above major functions and positions there are a number of other positions which support the major functionaries. They have been depicted in **Figure 1** outlining the members of the IRT at a block level and the chain of command; there may be shortage of personnel, so Officers who can do multi-tasking should be appointed and the support of community should be sought. All possible functions and requirements in any disaster will need to be covered. The NDMA Guidelines on IRS describe their responsibilities of the members of the IRT along with their functions [NDMA, 2009].

4. IRTs AT VARIOUS LEVELS

The IRT is a team comprising of all positions of IRS organisation headed by IC and supervised and supported by RO. The Operations Section helps to prepare different tactical operations as required. The Planning Section helps in obtaining different information and preparing plans as required. The Logistics Section assesses the availability and requirement of resources and takes action for obtaining them.

IRTs will function at State, District, Sub-Division and Block level. These teams will respond to all natural and man-made disasters. The lowest administrative unit (Sub-Division, Tehsil or Block) will be the first responder, as the case may be. If the incident becomes complex and is beyond the control of local IRT, the higher level IRT will be informed and they will take over the response management. In such cases the lower level IRT will merge with higher level IRT. Since the pattern and structure at all levels are the same, the lower level team will merge with the same concerned level position, section etc. of the higher level team. The IC of the higher formation may however decide on any other duty.

5. TRIGGERING MECHANISM

5.1 With Early Warning

Some of the natural hazards have a well established early warning system. States and Districts also have a functional 24 × 7 EOC or Control Room. On receipt of information regarding the impending disaster, the EOC will inform the RO, who, in turn, will activate the required IRT (State, District and Subdivision, as the case may be), and mobilise resources. The scale of their deployment will depend on the severity of the warnings.

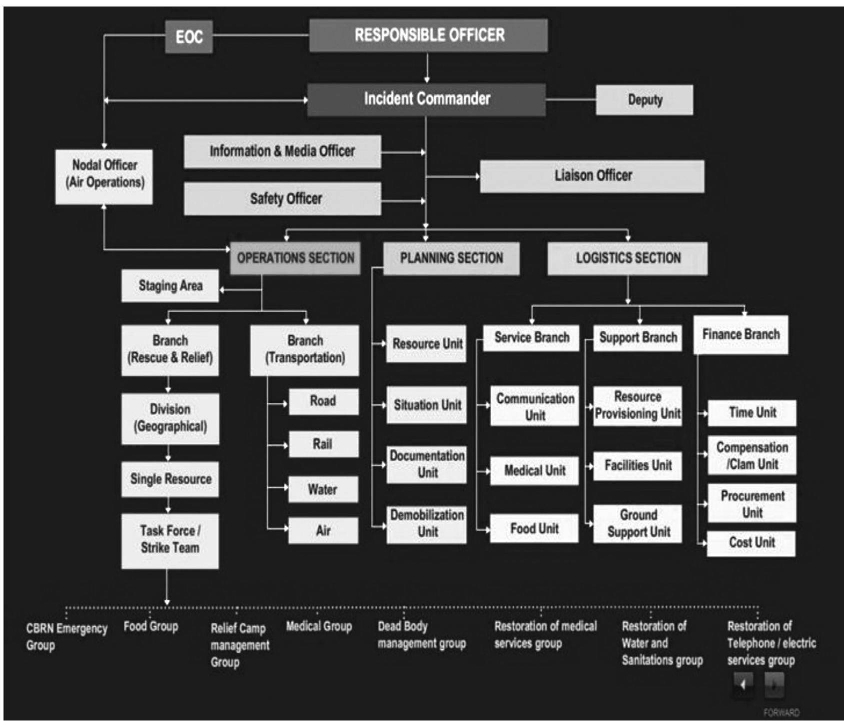

Figure 1: Composition of an IRT at a Sub-Divisional or Block level, and the chain of command

5.2 Without Early Warning

At times, the information about an incident may be received only on its occurrence without any warning. In such cases, the local IRT (District, Sub-Division, Block, as the case may be) will respond and inform the higher authority for reinforcement and guidance.

6. COMMUNITY PARTICIPATION

A number of community based organizations, like NGOs, Self Help Groups (SHGs), Youth Organisations, Volunteers of NYK, Civil Defense (CD) and Home Guard, and workers of different projects funded by Government of India (like National Rural Health Mission (NRHM), and Integrated Child Development Services (ICDS)) may be involved for smooth disaster response. These organisations may be placed at the disposal of the Operations Section and Planning Section.

7. FEATURES OF IRS

7.1 Management by Objective

Management by Objectives (MBO) covers four essential steps. These steps should be taken note of, when managing any incident, regardless of its size or complexity. They are:

(1) Understand Government policy and directions, including relief code, norms of ex-gratia payment, evacuation and in cases of deathpost-mortem procedures;

(2) Establish the incident objectives;

(3) Select appropriate strategies for implementation of IAP; and

(4) Perform tactical moves (assigning right resources, monitoring performance, *etc.*).

7.2 The Incident Action Plan

Before taking up response activities, the RO/IC will need to take stock of the situation, availability and mobilisation of resources, for listing out the various tasks and to provide proper briefing to the responders. This listing of tasks is the Incident Action Plan (IAP) and an *Incident Briefing Form* 001 has been provided in the IRS for this purpose. For this, the RO/IC will need to hold a proper briefing meeting at the beginning of each operational period (12 hours is one operational period). At the end of the operational period, a debriefing meeting is equally important by RO/IC, where RO/IC will again review whether the objectives were achieved or not and then decide what further steps need to be taken in the next operational period. Both the briefing and debriefing meetings are the basis on which the next IAP will be prepared and tasks assigned. The Incident Briefing Form 001 can be used for briefing senior officers about the incident, who arrive at the Incident Command

Post (ICP). Also, it can be conveniently used to keep all higher ups informed, whenever required.

IAP can be written or oral depending on the duration and magnitude of the incident. The incident may be of low, medium or large levels. A *low level* incident would be of less than 24 hours, a *medium level* incident of more than 24 hours and less than 36 hours, and a *large level* incident of more than 36 hours of emergency operations. In low and medium level incidents, oral action plan may suffice. The directions given orally should be written down by the Command Staff, and handed over to the Planning Section (PS) to be integrated in the IAP.

At times, there may be sudden disasters without warning and the RO/IC may have to respond immediately. There may be no time to prepare an *Incident Briefing Form*, and in such cases also, the Command Staff will write down the decisions taken for response, and hand it over to the Planning Section, when it is activated so that it may be incorporated in the first IAP as "Action Already Taken."

7.3 Organisational Flexibility

The IRS organisation is a need based, flexible organisation. All components need not be activated simultaneously. It would depend upon the nature and requirements of the incident. Each activated Section, Branch or Unit must have an Officer-in-charge to perform its role.

7.4 Span of Control

Span of control refers to the number of elements (Section, Branch or Unit) that one supervisor can directly manage effectively. Ideally, a supervisor should have a maximum of five organisational elements or resources (sections, branches, units, task force, strike teams, etc.) under his/her control. This system will help the supervisors of task force or strike teams to address various needs of the different units. For example, human resources deployed in the field may need fuel for movement, arrangements for stay, and other similar problems/ issues, suitable arrangements can be made by the Supervisor. Often, when a large number of units are deployed for emergency response, it has been seen that it becomes impossible to watch the progress or difficulties of all the units and take steps to address those issues immediately. If they are not sorted out, the concerned resource will be wasted. It is for this purpose that the IRS recommends that for every five such units deployed there should ideally be one supervisor to urgently sort out the matter.

7.5 Multi Tasking

In some cases, because of lack of personnel, a single supervisor may be made in-charge of more than one Group, Unit or Section. It should be clearly understood that in such cases, the Groups, Units and Sections do not get merged or amalgamated. Their functioning would continue to be independent. Only the supervisor will be looking after two different sections. The organisational elements that are no longer required should be deactivated to reduce the size of the organisation and to ensure appropriate use of resources.

7.6 Personnel Accountability

A clear cut chain of command ensures that one officer or a Unit/Group/Task Force/Strike Team is not assigned to more than one **s**upervisor. It makes the response effort absolutely focused and leaves no room for unsupervised activity. It helps maintain a complete record of all activities performed and resources deployed. There are various procedures and forms which ensure accountability in the IRS. Without going into a detailed description of each form and showing how it ensures accountability, it would suffice just to mention some of the important forms which are meant for accountability and supervision. These forms are:

(1) Incident Briefing Form 001;

(2) Incident Status Summary Form 002;

(3) Unit Log Form 003;

(4) Record of Performed Activities Form 004;

(5) Organisation Assignment List Form 005;

(6) Incident Cheking And Deployment List Form 006;

(7) Medical Plan Form 008;

(8) Incident Communication Plan Form 009; and

(9) Demobilisation Plan Form 010.

7.7 Resource Management

In IRS, resources are managed and assigned under specific terminology to denote their category and employability. All resources are designated according to the 'kind' and 'type'. 'Kind' would mean the overall description of the resource (like Bus, Truck and Bulldozer, and Medical Team). 'Type' would mean the performance capability of the resource (which may be large, medium or small). This helps in ordering the exact and correct resource by the ordering unit. Also, it helps the deploying agencies to send the correct requirement. The terms used are as follows:

(a) *Single Resource*: Single Resource includes both personnel and their equipment;

(b) *Strike Team*: A Strike Team is a specified combination of a designated number of the same *'kind'* and *'type'* of resources with common communications and a leader/supervisor. Strike Teams can be pre-designated or assembled at an incident site/ staging area from the available Single Resources as per demand of the situation;

(c) *Task Force*: A Task Force is any combination of Single Resources of different 'kinds' and 'types' within the ambit of a specific span of control to perform different types of functions simultaneously. They are assembled for a multi-tactical task in a particular location with common communications and a supervisor/leader. Task Forces can be pre-determined or assembled for response in an incident site or at staging area from available Single Resources according to the requirement;

(d) *Resource Status*: Tactical resources assigned to an incident will always be in any one of the following status conditions;

(e) *Required*: Resources that would be needed to respond to disasters effectively and which need to be obtained;

(f) *Available*: Resources ready for deployment in the staging area;

(g) *Assigned*: Resources on active assignment; and

(h) *Out-of-Service*: Resources not assigned or not available because of repair or maintenance.

7.8 Common Terminology

In IRS, common terminology is applied to Organisational Elements, Position Titles, Resources and Facilities, which are:

(a) *Organisational Elements:* There is a consistent pattern for designating each level of the organisation (*e.g.,* Sections, Branches, Divisions and Units);

(b) *Position Titles:* Those charged with management or leadership responsibility in IRS are referred to by specific position titles such as Responsible Officer, Incident Commander, Officer, Chief, Director, Supervisor, Leader, and In-charge. It provides a standardised nomenclature for requisitioning personnel to fill various levels of positions.

(c) *Branch:* The organizational level having functional or geographic responsibility for major segments of incident operations. The Branch is found in Operations and Logistics Sections. It is based on various functional requirement of the Section.

(d) *Division + Area Command:* Divisions are used to divide an incident into geographical area of operations. It is positioned in the IRS organization between the Branch and Groups. Divisions are established when number of resources deployed exceeds the span of control of the Operations Sections Chief. Area Command is activated for closer supervision when an area is distant or isolated and reaching there is time consuming and difficult.

(e) *Group:* Group refers to only functional responsibilities for major segments of Incident operations. Group consists of different functional teams (Single Resources, Strike Teams and Task Forces).

(f) *Resources:* Resources are grouped into three categories: Single Resources, Strike Teams and Task Forces.

(g) *Facilities:* Different kinds of facilities may need to be established to meet the specific needs of the incident. IRS tries to standardize them by using common terminology, like Incident Command Post, Emergency Operation Centre, Staging Area, Incident Base, Camp, Relief Camp, Helibase and Helipad. The details of facilities and its symbols have been enumerated in the NDMA Guidelines and efforts have been made such that the availability of all necessary things required for response are available and not missed out.

8. COMMAND AND CONTROL

8.1 Transfer of Command

Command for an incident is initially established by the highest ranking authority of the administrative jurisdiction of state administration. Transfer of Command at an incident may take place for the following reasons:

(1) End of operational period that is 12 hours; OR

(2) When head of the higher formation of IRT or Senior officer assumes command.

To make this transfer of command more clear, specific and avoid any waste of time in understanding the situation for facilitating quick and effective response, IRS provides for use of standard forms, such as *IRS 001* for *Initial Briefing* of the Incident and *IRS 015* for Planning of IAP.

8.2 Unity and Chain of Command

In IRS, the Unity of Command means that every individual has a designated supervisor. Chain of Command means that there is an orderly line of authority within the ranks of the organization with a clear cut reporting pattern right from the lowest level to the highest. In the IRS, the Chain of Command is established through a prescribed organisational structure which consists of various layers such as Sections, Branches, Divisions, Task force, and Strike Team.

The advantages of having a chain of command are that it:

(1) Eliminates the possibility of receiving conflicting orders from parent organisation;

(2) Increases accountability;

(3) Prevents freelancing; and

(4) Improves the flow of information, and helps in smooth coordination in operational efforts.

8.3 Integrated Communication

The ability to communicate within the IRS structure is very important. A provision has been made for a complete Communication Unit in the Logistics Section. Several communication networks may be established depending upon the size, complexity of the incident, availability of various types of equipment and the simultaneous need to communicate by a number of responders and agencies. These may include Command Net, Operational Net, Logistics Net, and Ground to Air Net. Also, a suitable interoperable and compatible network between various agencies will has to be designed. This networking is vital for the integration of agency capabilities (like the NDRF and Armed Forces), when they come in aid and support. The Government of India is working concurrently on a National Disaster Communication Network (NDCN), which will be useful in extreme disasters when all existing communication systems have failed.

8.4 Unified Command

Unified Command is an IRS management process, which allows all agencies that have jurisdictional or functional responsibility for the incident, to jointly develop a common set of incident objectives and strategies. This is accomplished without losing or giving up agency authority, responsibility, or accountability. A Unified Command is an important feature of IRS. It allows agencies having a legitimate responsibility at an incident to be part of the Incident Command function.

Under Unified Command, the following always applies:

(a) One Incident Command Post will be established at state level headed by Chief Minister, supported by Chief Secretary and Secretary Disaster Management and senior most Officer of the different department / agencies deployed for the Disaster Response. The same system will be replicated at district level headed by RO/DM supported by all participating agencies for successful implementation of IAP and resolve conflict if any among the participating departments;

(b) The Incident Commander will function under a single coordinated Incident Action Plan; and

(c) One Operations Section Chief will have responsibility for implementing the Incident Action Plan.

9. CLOSING COMMENTS

The IRS of India is the backbone for effective Response by the stakeholders after disasters. Its current version has been conceived carefully after examining the administrative, technical and social conditions of the country. The early gains are clear, but the larger gains of the IRS introduced in the country will be unravel over with time...

References

1. NDMA, (2009), National Disaster Management Guidelines on Incident Response System, National Disaster Management Authority, Government of India

https://www.ndma.gov.in/sites/default/files/PDF/Guidelines/incidentresponsesystemjuly.pdf

Accessed on 18 November 2020

E. THE ROAD AHEAD FOR DISASTER MANAGEMENT

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The Road Ahead for Disaster Management in India

Abstract: The stage is set for Disaster Management (DM) in India… The basic legal framework is in place. The needed finances are available in a systemic way. The central and state administrations are prepared. Drills and rehearsals are ensuring stakeholder ownership and practised readiness. And, we have the early experiences, both the elating success on the reduced losses during the Cyclones in the recent past, and the humbling unaddressed high vulnerability of the built environment. The residual agenda is glaring at us and will humble us when hazards occur. This paper presents the agenda that needs to be addressed to make substantive progress – by 2030. It includes: (a) articulating Systems and Processes, (b) embarking on Long Term Agenda of solving the difficult problems, (c) building the needed Human Resources, especially the technical ones, (d) beginning the Implementation of the DM measures of Mitigation and Preparedness, especially the retrofit of select prioritized built environment, and (e) ensuring documentation of all new disasters and capturing the perishable lessons. It is prudent to make an *imperfect start* now than to wait for the ideal one…

Key Words: Systems and Processes, Long Term Agenda, Human Resources, Implementation, Documentation

1. INTRODUCTION

The word "Disaster Management" (DM) has reached the desks of:

(1) All Ministries, Departments and Offices concerned of the Central Government and State Governments, and UT Administrations;

(2) Almost all educational institutions across the country, and

(3) Nearly all small, medium and large industries in the country.

The next step is to internalize it. One convincing way of doing this is by practicing it. But, for the effort of about 132 Crore people in India to be in consonance, an organized, proactive and prioritized effort is required.

2. CREATE SYSTEMS AND PROCESSES

The mind is the most difficult to share crisply and accurately. Yes, this is the pre-requisite to building institutions. In DM too, mainstreaming Mitigation and Preparedness and getting ready for Response needs to be done at three levels of human consciousness, namely *thoughts*, *words* and *deeds*. Only when all stakeholders internalize the DM principles in their *thoughts* and articulate the needs precisely in logical and convincing *words*, can their *deeds* be sustainable.

2.1 Policies, Plans and Guidelines, Norms and Procedures

Developing a culture of *safety* and *prevention* across the people of India is the focus. If the minds of 132 Crores of people have to align towards the same goal of *well-being* and *safety* of all, creating systems and processes is mandatory. In DM, this is achieved by articulating in print the Policies, Plans, Guidelines, Norms and Procedures in line with the DM Act, 2005. This needs to be achieved at all levels, namely National, State, District, City/Town/Village and Community. Each of these should flow and be consistent with the higher level document. Of course,

(1) A State can have additional items beyond those listed in the National Policy on DM;

(2) A District can add a few items more than those listed in the State Policy on DM;

(3) A Town/City a few more items over those listed in the District DM Policy on DM; and

(4) A Community a few more items over those listed in the Town/City/Village DM Policy.

Likewise, towards streamlining a large number of people nationwide to be engaged coherently in the activities of DM, each should have Plans, Guidelines, Norms and Procedures customized with additional items, and without jeopardizing the intent of the corresponding document at the higher level(s).

While the National Policy on DM is in the nature of an overarching policy framework, at the lower levels, *i.e.,* the States, districts, towns and villages, additional imperatives will have to be factored in, to respond to local imperatives, such as the terrain, the disasters to which given areas are vulnerable, and the social, economic and cultural features of the people. This is also applicable to the DM framework starting with the Act, and through the policy, the guidelines, and the plans, up to the measures (structural and non-structural) arising therefrom. Only when such a tiered documents (of Policies, Plans, Guidelines, Norms and Procedures) are made available at all levels, do the hands that implement DM initiatives feel comfortable that their effort has a destination. Also, especially in governmental system of transfers, the changing hands that handle the ongoing and new DM activities should have these documents as recourse to seeking clarity.

Fortunately, the Policies, Plans, and Guidelines are available on many aspects of DM already at the national level; some Norms and Procedures may have to be added. With this the States should embark on preparing their parallel documents. In this exercise, the designated officers should be co-opted from the Districts. In turn, the participants from the Districts should embark on preparing their parallel documents, this time co-opting the designated officers from the Towns and Cities and the Communities also. While this may sound too ideal, *an imperfect start* is a perfect start! So, the work should begin simultaneously at all the levels, and the dialogue must be completed within a targeted time. Clearly, the urgency of completing the documents at the higher levels cannot be underscored. Further, while drawing up DM plans at the various levels (national, states & UTs, and districts), the international understanding of sustainable development goals (*e.g.,* UN SDGs) should be a guiding light at all times. Launching the relevant UN Interventions towards Disaster Mitigation and Risk Reduction should stay as a backdrop of DM activities in India.

2.2 Practice

The importance of the techno-legal environment being kept contemporary and duly updated cannot be over-emphasised. Continuous and meaningful dialogue is needed with the stakeholders engaged in the techno-legal environment by the authorities concerned at all levels, especially the national and state levels, so that the process of learning from earlier mistakes, and emulating best practices, can continuously inform the updation of the Policy and Plan documents at all levels. Of course, the practice of DM will provide valuable experiences that will need to be again taken back to the discussion table, and eventually revise the Policies, Plans, Guidelines, Norms and Procedures, and even the DM Act possibly.

3. START WORK ON THE LONG TERM AGENDA

In all management environments, the urgent always crowds out the important. Therefore, while things that need to be responded to immediately should be given the attention they need, the importance of long term planning and associated groundwork should not be neglected. In DM (as in life), the *urgent* and *important* works get done under duress (**Table 1.1**). But, the work involved in DM is not small to accomplish in a short time. It is huge, and needs substantial resources of human beings, time and money. Often, these are available in small packets. But, in DM, the key is the consistent flow of all these three resources. This limited resource coupled with the *Systems and Processes*, which are put in place, can accomplish substantive progress over a period of time.

Table 1.1: Priority to Pre-Event activities in allocating Resources

Important	**Urgent**	
	Not Urgent	**Urgent**
Not Important	None in DM	None in DM
Important	**Prevention Mitigation** (and associated Preparedness)	**Response** (*i.e.,* Rescue and Relief) (and associated Preparedness) **Recovery** (*i.e.,* Rehabilitation and Reconstruction)

Progress will be significant in DM only when the focus is on activities that have good gains in the long-run. Hence, a lion's share (say, 80%) of the resources should be pledged such effort; the pre-event activities related to Prevention and Mitigation are candidates for this along with the associated activities related to Preparedness. The rest of the resources (~20%) should address pre-event activities related to Response and Recovery along with the associated activities related to Preparedness.

There are initiatives that neither have political mileage nor give administrative appeal, but are of paramount importance in the context of protecting the people of the country in the long-run. Typical among these are activities relating to the maintenance of structures, such as government buildings, roads, irrigation dams, power plants, and manufacturing units. Into the same category fall works, such as balancing reservoirs which, while serving the important purposes, of both preventing floods and storing precious water for irrigation purposes, offer little political gain or administrative interest.

While everything may appear important and choices may appear difficult, it is necessary for all authorities systematically to prepare lists of available options and order them in a sequence of descending order of priority. It is only then that the task of addressing what needs to be done should be taken up, having regard to the human and financial resources available and the timeframes. And, when a destination has been identified in terms of promised quantified deliverable outputs, and the financial, operational legal and administrative implications spelt out, a road-map need to be drawn to the destination, duly marked off by milestones and sign-posts. Also, the entire journey monitored by an external and independent agency, which should be associated with the entire chain of activities from *Design*, through *Implementation* and *Monitoring* and finally to *Evaluation (DIME)*.

3.1 People's Safety

Comprehensively ensuring the structural safety of the built environment is yet unattended to. Two actions are needed in this regard, namely: (a) Ensuring that all new structures are disaster-resilient, and (b) Beginning to retrofit the existing deficient constructions, especially the critical and lifelines structures to begin with. Systems and processes are needed to be established towards this end; local governments need to prepare renewed building permit systems in villages and towns.

As per the Census of 2011, India has ~30.5 Crore houses [BMTPC, 2017]. Of this ~29.4 Crore houses are made of masonry (which is largely non-engineered and self-built) and 1.1 Crore are made of reinforced concrete (RC, which are claimed to be engineered). The hazard resistance of these houses needs to be ensured. For instance, with ~78% of India living in seismic zones III, IV and V, and ~80% of these houses under the threat earthquake shaking, the safety is in the question of ~100 Crore people of India, because both masonry and RC structures did not perform well in the past earthquakes in India. *Methodologies for Hazard Safety Assessments* and *Techniques for Strengthening* of these houses need to be developed. But, this is resource and time intensive. Overall, these are critical inputs to any rational assessment of the risk to which the people of India are put to.

Similarly, schools hold the next generation of the community, and hospitals and civic infrastructure (transportation, communication, water, food, *etc.*) are needed to be functional when disasters strike. These structures should be robust enough to have no distress to remain functional after disasters. Considering the general plight of the disaster resistance of the built environment across the country, these structures should be assessed and retrofitted as the topmost priority of the nation.

3.2 Protection of Livelihood Resources

Protection of livelihoods requires safeguarding the resources from where people draw livelihood, *e.g.,* water bodies, forests, rangelands, parks/gardens, and nurseries, besides industrial, commercial and government-owned service establishments. They hold the key of community resilience against the impact of disasters, because they determine the capacity to reduce their own vulnerability and prepare to counter sudden spikes in the demands during the disaster situations. Alongside, safeguarding animals and the role of animals in disaster risk reduction is a major facet of sustainable development in the backdrop of DM.

4. GROOM MORE HUMAN RESOURCES

Competent human beings are the need of the hour in DM in India. And, Competence in human beings arises out of a complex combination of their positive attitude, useful skills and sufficient knowledge. Currently, the nation has very few persons in each subject (either in each Hazard or in each Cross-Cutting Theme), who are available for DM with a sense of service. Protecting 132 Crores of people in various themes cannot happen with such limited human resource; no extra outlay of financial resource and availability of time can make up for this acute shortage. Grooming more persons, who have the requisite competence in the various facets of DM, is the only (and *one-way*) street for India today…

Subject Specialists are needed at the all levels (and of different types of competence) in each *Hazard* (Floods, Cyclones, Earthquakes, Landslides, *etc.*) and in each *Cross-Cutting Theme* (Health, Education, Search & Rescue, GIS, *etc.*). Technical Institutes (such as Architecture Colleges and National Institutes Technology) should include Disaster Resistant Technologies as a mandatory undergraduate curriculum. Only when this is done, the graduates from these Colleges and Institutes will be internalize Disaster Resistant Technologies. The seriousness of the mattes is more pointed in *earthquake safety*, where only 7 government engineering colleges of Gujarat of the over 3,000 colleges of Civil Engineering and 470 of Architecture had earthquake-resistant design as *mandatory* part of the curriculum. Unfortunately, even this was discontinued in 2016, and today no college teaches the subject as part of the mandatory curriculum. Also, the subject of DM is inter-disciplinary and *non-traditional*, because it involves a significant focus on operational and practical aspects of leaning while doing, besides using analytical tools and undertaking planning exercises. This would require suitable encouragements for cooperation between subject specialists of different disciplines; this does in no way seek the same person to acquire knowledge in diverse fields.

Generalists are required to skillfully and efficiently manoeuver through and juggle with the limited resources (people, time and money) to conduct the various DM activities. This pool of Subject Specialists and Generalists need to occupy the DM spaces in:

(a) Communities, City/Town DM Offices to work with Municipalities and Departments,

(b) DDMAs to work with District Administration and Departments,

(c) SDMAs to work with State Administration and Departments, and

(d) NDMA to work with Central Administration, Ministries and Departments.

Also, an even larger number of competent persons are required in various private and government industries and businesses.

Generally, the performance of an organisation is as good as the technical qualifications, levels of training and hands-on experience, of the people who drive the process of achieving the objects for which it is intended. The primacy of the role played by HRD in the management of disasters at various levels in the country can therefore be hardly over-emphasised. The resourcefulness of the individual, after all, is the best resource the country has! To this end, it is necessary to ensure that a pool of expertise fuels the engine of DM apparatuses at various levels – with subject matter specialists bringing in specialised skills in niche areas and generalists (including the civil administrations, and local self – government bodies community-based organisations), adding the value of their experience and wisdom to the efforts entrusted to the DM authorities.

Needless to say, that such expertise can be either in the domain of public administration or from the corporate sector, apart from that available with scientific and technical and academic institutions. In this context, authorities at all levels should be wary of *biting off more than they can chew* or *chewing more than what they can swallow*.

5. PACE UP IMPLEMENTATION

Individuals, rather than institutions, need to drive the DM process in the future. Mainstreaming of DM has to be done at three levels, namely *thought*, *word* and *deed*. The subject of DM is *too big to gobble* in one shot; the only way is *to nibble at it* each day, every day, and from today! Pacing-up is the crucial in the implementation of DM across the country. But, the acute shortage of available needed human resources, demands that a special strategy is required to implement DM strategies and plans in a comprehensive way across India. In this regard, decentralization of DM to DDMAs (with due supervision from SDMAs) is essential. Therein, Preparedness for Response largely should be the onus of the DDMAs.

With an imperfect start of DM already staring at us, it is time to launch a Model District Program with focus on implementing DM. The main features of this program are:

(1) All DM activities will be undertaken in one small District of the country, which that is under the threat of at least three major hazards.

(2) All available (but scarce) human resources of Subject Specialists (in each *Hazard* and in each *Cross-Cutting Theme*) will be brought together to implement DM in one district in the country.

(3) In this District, the following will be undertaken:
   (a) All Systems and Processes will be established.
   (b) DM will focus especially on work related to long term agenda (Prevention, Mitigation and associated Preparedness activities).
   (c) Required number of human resources will be groomed to be competent in their areas of work (*i.e.,* specialists and generalists).
   (d) Implementation will be fast-tracked (say, in a limited period of 1 year).
   (e) The entire process of implementation will be documented and showcased to the other states and districts across India from the second year onwards.

5.1 The Imperfect Start – The Gut Feeling

The *best* is the enemy of the *good*! In the nascent days of implementing DM at the District Level in India, an imperfect start is understandable… Until a more refined assessment of risk is made available by subject specialists, it is important to move forward with *first-cut* projections of risk. Towards this end, a consensus method (like the *Delphi Method*) should be adopted to go forward with the *gut feeling*, than to wait for the accurate assessment of risk.

6. DOCUMENT AND SHOWCASE LESSONS LEARNT FROM FAILURES

Documentation remains a glaring weakness in the extant DM system at all levels in the country. Granted, visits undertaken too close to the occurrence of a disaster would amount to interference with the rescue and relief operations. On the other hand, those which happen much later will fail to connect with reality on account of the efflux of time having erased most of the perishable (or erasable) evidence at the grassroots level.

In the ladder of learning (namely *reading*, *memorizing*, *thinking* and *lecturing*), the efficiency of learning is most in the fourth phase, namely when we share the lessons learnt with others. Further, sharing the lessons with others is most efficiently done through detailed documentation, in addition to orally sharing with others. Furthermore, of the lessons learnt, the ones learnt from failures have a lasting impact on human minds. Hence, those should be shared particularly with stakeholders engaged in DM.

Clearly, the authorities at various levels from the national to the local will need to be equipped with books of instructions/manuals in which what is needed from them is clearly stated. Dissemination should be bullish, continuous, and from all levels. There are various forms in which the dissemination can happen. Some of these are:

(1) Websites of NDMA, SDMAs, DDMAs and City DMAs, on which all documents are uploaded systematically with search engines and filters to assist;

(2) Annual Conferences on DM organized in a staggered way at the City, District, State and eventually at the National level; and

(3) Video documentation of advantages of undertaking Mitigation measures, *e.g.,* retrofitting of the built environment for earthquake safety.

7. CLOSING COMMENTS…

The use of modern technology and state-of-the-art equipment improve the accuracy and relevance of post-event studies. Quite obviously the format of the study should be so designed, as not merely to highlight the good practices that can be emulated and scaled up subsequently, but also focus on the failures from which it would be possible to learn what not to do in the future. The conclusions arising from such studies can serve the purpose only if they are widely disseminated to all the stakeholders including the community through the print and electronic media, journals on the subject of DM and fora such as seminars and workshops.

Given the bewildering complexity of the unfolding canvas, and the rapidity with which change is occurring, it is absolutely imperative that the DM apparatus at all levels remains constantly tuned to the external environment, always on the lookout for threats and opportunities, in an online and real-time mode. All effort and activities spanning the DM continuum should remain driven by the imperatives of environmental sensitivity. The need to protect preserve, protect and defend the benefits of growth and development, which have resulted from long years of imaginative planning and in maculate implementation heads to remain upper must in the psyche of planners and administrators. Needless to say, all effort should be undertaken in an inclusive and participatory manner, apart from being transparent and accountable. Finally, especially in the area of reconstruction, it must be remembered that the challenge presented by the occurrence of a disaster is really, in the long run, an opportunity to build back better!

References

1. BMTPC, (2017), *Vulnerability Atlas of India*, Buildings Materials and Technology Promotion Council, New Delhi

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