DISASTER MANAGEMENT AND ROLE OF ARMED FORCES

A Dissertation submitted to Panjab University, Chandigarh for award of Master of Philosophy in Social Sciences, in partial fulfillment of the requirement for the Advanced Professional Programme in Public Administration (APPPA)

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CERTIFICATE

I have the pleasure to certify that Air Commodore Sanjay VSM of the Indian Air Force has pursued his research work and prepared the present Dissertation titled "Disaster Management and Role of Armed Forces" under my guidance and supervision. The dissertation is the result of his research and to the best of my knowledge, no part of it has earlier comprised any other monograph, dissertation or book. This is being submitted to the Panjab University, Chandigarh, for the purpose of Master of Philosophy in Social Sciences in Partial Fulfillment of the requirement for the Advanced Professional Programme in Public Administration of the Indian Institute of Public Administration (IIPA), New Delhi.

I recommend that the dissertation of Air Commodore Sanjay is worthy of consideration for the award of M.Phil degree of Panjab University, Chandigarh

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India has been traditionally vulnerable to natural disasters on account of its unique geo-climatic conditions. Floods, droughts, cyclones, earthquakes and landslides have been a recurrent phenomenon. One of the most important and immediate requirements after a disaster is to provide affected communities with immediate relief so that they can live with dignity and work towards resuming their normal lives. As a part of the course curriculum, a study was carried out to analyse and evaluate evolving structures for Management of Disasters and role of Indian Armed Forces with an aim to recommend value addition in terms of more Effective Integration of Armed Forces with State & Central Organisations in Disaster Management apparatus.

The objective of this dissertation is to study existing framework and approach to Disasters Management in India and identify the scope on the role of Armed Forces with special emphasis on application of Science & Technology, Artificial Intelligence, Big Data and Knowledge Management in evolving comprehensive plan for an effective handling of Disaster Management in India. Derive Interpolation of strategies, based on the above learning's and rollout suggestions / recommendations for effective emergency system and disaster response management processes to the government and the Armed Forces HQ.

The preparation of this dissertation involved an extensive process of consultations, reviews, referrals and discussions with seniors Government officials, experts on the subject, Senior Functionaries from the National Disaster Management Authority - Maj Gen (Dr) VK Naik (Retd) and Brig Ajay Ganghwar who provided guidance, updates on the current policies, provided valuable inputs and continuously reviewed the progress of the study I gratefully acknowledge their contribution.

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(Sanjay)
Air Cmde

In loving Memory of……..

This Dissertation is Dedicated to my late Mother
Prof (Dr) Shakuntala Verma,
Who was a
Brilliant scholar, Humble, caring and the most Fantastic parent
anyone could've asked for.
She has, all through her life, been a great source of Motivation, and instilled in me the Drive, Discipline and the Confidence
to tackle any task with Enthusiasm and Determination.
We feel your presence every day Mommy
and you continue to inspire us……

LIST OF ABBREVIATIONS

ACIDS	Assistant Chief of Integrated Staff
ADPC	Asian Disaster Preparedness Centre
AESA	Active Electronically Scanned Array
CBRN	Chemical, Biological, Radiological and Nuclear
CDS	Chief of Defence Staff
CISC	Chief of the Integrated Defence Staff and the Chairman, Chiefs of Staff Committee
CMG	Crisis Management Group
COSC	Chief of Staff Committee
CSSR	Collapsed Structure Search & Rescue
DDMA	District Disaster Management Authority
DGMO	Director General Military Operations
DRR	Disaster Risk Reduction
DSSC	Defence Services Staff College
EOC	Emergency Operational Centre
ESF	Emergency Support Functions
ETF	Engineer Task Force
HADR	Human Assistance to Disaster Relief
HAM	Ham Radio
HPC	High Powered Committee
IDNDR	International Decade for Natural Disaster Reduction
IDS	Integrated Defence Staff
INCP	Interim National Command Post
SOPs	Standard Operating Procedures

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CHAPTER- I

INTRODUCTION

The source of man's unhappiness is his ignorance of Nature.

Paul Henry Thiry d'Holbach

Background

1.1 Disaster may be defined as sudden, catastrophic event, bringing great damage, loss, destruction and devastation to life and property. The damage caused by disasters is immeasurable and influences the psychological, socioeconomic, political, and cultural state of the affected area. Disasters are events that impose great damage, destruction, and human suffering. Disasters are often classified according to whether they are ***"natural"*** disasters**,** or ***"human-made"*** disasters. Any disasters caused by floods, cyclones, droughts, Tsunamis and earthquakes are generally considered "Natural Disasters", while disasters caused by chemical, biological or industrial accidents, environmental pollution, transport accidents and political or union unrest are classified as "human-made" or "human-induced" disasters since they are due to human action.

1.2 Managing climate-related risks is an important issue for development of any place. Identifying and reducing risks associated with climate-related hazards can help to protect people, their livelihoods and assets, thereby promoting sustained Developmental Goals. Disaster risks don't exist in isolation. They are a result of the interaction between natural hazards and human activities. Only concerted efforts between all the stakeholders can tackle these risks, strengthen resilience and help the country move towards a better and safer environment.

1.3 The term 'Disaster' owes its origin to the French word '**Disaster'** whereby '**des'** means evil and '**astre'** stands for star. Thus the term literally means an **'evil star'.** Webster dictionary defines disaster as a sudden calamitous event

producing great material damage, loss and distress. According to Section 2(d) of The Disaster Management Act 2005 defines "Disaster as a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or be 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"[1].

1.4 Disaster management is essentially a ***dynamic process***. It comprises of management functions like planning, organizing, staffing, leading and controlling. It also involves many agencies working jointly to prevent, mitigate, prepare, respond and recover from the effects of disaster. The loss in terms of private, community and public assets due to disasters has been astronomical. Apart from natural disasters, some cities in India are also vulnerable to chemical, industrial and other manmade disasters. Lakhs of people are affected and huge economic losses are incurred every year due to natural disasters; and directly affect growth of Gross National Product of the country. Natural Disasters are huge burden on the economy of any developing economies such as India. Section 5(e) of DM Act 2005 defines ***"Disaster Management"*** as "means a continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary or expedient for:-

(*i*) Prevention of danger or threat of any disaster;

(*ii*) Mitigation or reduction of risk of any disaster or its severity or consequences;

(*iii*) Capacity building;

(*iv*) Preparedness to deal with any disaster;

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1 *Sec 2(d & e) of Disaster Management Act 2005*

(*v*) Prompt response to any threatening disaster situation or disaster;

(*vi*) Assessing the severity or magnitude of effects of any disaster

(*vii*) Evacuation, rescue and relief;

(*viii*) Rehabilitation and reconstruction;

1.5 The U.N. International Strategy for Disaster Reduction (2009) uses two terms to encompass disaster management: one is ***"Disaster Risk Management"*** which is the systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards. The other is ***"Disaster Risk Reduction"*** which is the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development. Interestingly, the Govt of India policy makers on Disaster Management has incorporated this philosophy while framing policies and directives on the subject matter[2].

Historical Perspective

1.6 India has been traditionally vulnerable to natural disasters on account of its unique geo-climatic conditions. Floods, droughts, cyclones, earthquakes and landslides have been a recurrent phenomenon. About 60% of land is earthquake prone of various magnitudes'; over 40 million hectares of agricultural land is prone to floods; about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought. In the decade 1972-2014, around 62815 people lost their

[2] *The U.N. International Strategy for Disaster Reduction -2009*

lives and millions of people were affected by disasters every year[3].

SOME MAJOR DISASTERS OCCURRED IN INDIA AS PER NDMA STATISTICS[4]

S. No.	Name of Event	Year	State & Area	Fatalities
1.	Cyclone Fani	May 2019	Odisha	64 dead, affected about 1.65 Crore people in over 18,388 villages in 14 of the 30 Districts in the State
2.	Floods	October 2014	Jammu & Kashmir	N/A
3.	Cyclone Hud Hud	September 2014	Andhra Pradesh & Odisha	N/A
4.	Odisha Floods	October 2013	Odisha	21
5.	Andhra Floods	October 2013	Andhra Pradesh	53
6.	Cyclone Phailin	October 2013	Odisha and Andhra Pradesh	23
7.	Floods/Landslides	June 2013	Uttarakhand and Himachal Pradesh	4,094
8.	Cyclone Mahasen	May 2013	Tamil Nadu	08
9.	Cyclone Nilam	October 2012	Tamil Nadu	65

[3] *Disaster: Challenges and perspectives Auth: Kalpana Srivastava Pub- Ind Psychiatry J. 2010 Jan-Jun; 19(1): 1–4*

[4] *NDMA statistics*

10.	Uttarakhand Floods	Aug – Sep 2012	Uttarkashi, Rudraprayag and Bageshwar	52
11.	Assam Floods	July – Aug 2012	Assam	---
12.	Cyclone Thane	December 2011	Tamil Nadu, Puducherry	47
13.	Sikkim Earthquake	September 2011	Sikkim, West Bengal, Bihar	60
14.	Odisha Floods	September 2011	19 Districts of Odisha	45
15.	Sikkim Earthquake	2011	North Eastern India with epicenter near Nepal Border and Sikkim	97 people died (75 in Sikkim)
16.	Cloudburst	2010	Leh, Ladakh in J&K	257 people died
17.	Drought	2009	252 Districts in 10 States	-----
18.	Krishna Floods	2009	Andhra Pradesh, Karnataka	300 people died
19.	Kosi Floods	2008	North Bihar	527 deaths, 19,323 livestock perished, 2,23,000 houses damaged, 3.3 million persons affected
20.	Cyclone Nisha	2008	Tamil Nadu	204 deaths
21.	Maharashtra	July 2005	Maharashtra	1094 deaths

	Floods		State	167 injured 54 missing
22.	Kashmir	2005	Mostly Pakistan, Partially Kashmir	1400 deaths in Kashmir (86,000 deaths in total)
23.	Tsunami	2004	Coastline of Tamil Nadu, Kerala, Andhra Pradesh, Pondicherry and Andaman and Nicobar Islands of India	10,749 deaths 5,640 persons missing 2.79 million people affected 11,827 hectares of crops damaged 300,000 fisher folk lost their livelihood
24.	Gujarat Earthquake	2001	Rapar, Bhuj, Bhachau, Anjar, Ahmedabad and Surat in Gujarat State	13,805 deaths 6.3 million people affected
25.	Orissa Super Cyclone	1999	Orissa	Over 10,000 deaths
26.	Cyclone	1996	Andhra Pradesh	1,000 people died, 5,80,000 housed destroyed, Rs. 20.26 billion estimated damage
27.	Latur Earthquake	1993	Latur, Marathwada region of Maharashtra	7,928 people died 30,000 injured
28.	Cyclone	1990	Andhra Pradesh	967 people died, 435,000 acres of land affected
29.	Drought	1987	15 States	300 million people affected

30.	Cyclone	1977	Andhra Pradesh	10,000 deaths hundreds of thousands homeless 40,000 cattle deaths
31.	Drought	1972	Large part of the country	200 million people affected

Table 1.1[5]

India's Vulnerability to Disasters[6]

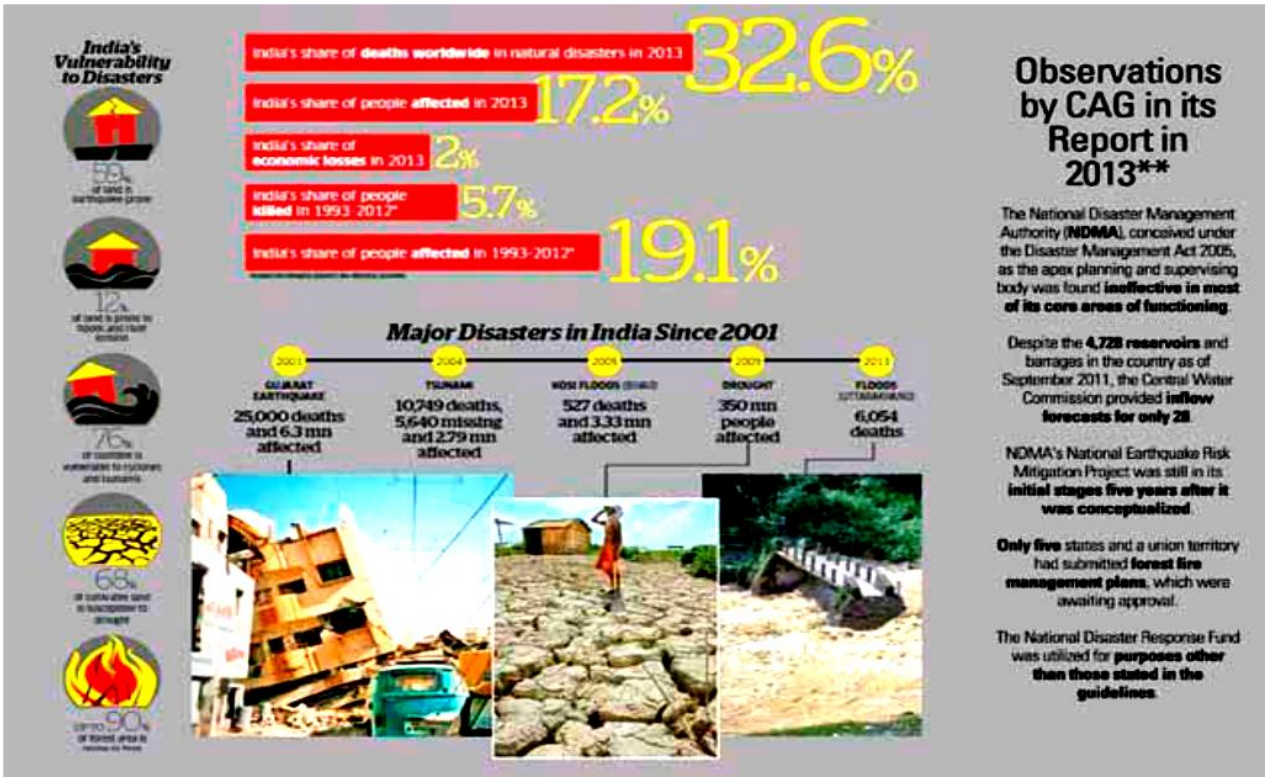

Fig 1.1

1.7. There has been a considerable concern over natural disasters world over. In spite of major advances in the field of science and technology, the loss of lives

[5] *NDMA Statistics*

[6] *Dharana - International Journal of Business from M. P. Birla Institute of Management, Bengaluru*

and property due to disasters has not decreased considerably. The human toll and economic losses have continued to be on the rise. Reduction of losses of lives and property and restrict socio-economic damage through concerted efforts, especially in developing countries continues to be a big challenge. While disaster resilient infrastructure calls for huge investments, there are certain areas where tangible results can be achieved with advanced planning and preparedness, and very little investment.

1.8. The super cyclone in Orissa in October, 1999 and 2019, the Bhuj Earthquake in Gujarat in January, 2001 and Tsunami in 2004 underscored the need to adopt a multi- dimensional attempt involving various processes involving varied scientific tools, engineering & technology, financial and social & Human engineering practices; the need to adopt multi-disciplinary and multi sectorial approach and incorporation of risk reduction in the developmental plans and strategies. Thus the National Disaster Management Act 2005, NDMA, NDRF & SDRFs and National Policy on Disaster Management 2009 came into being. Similarly National Institute of Disaster Management was established in Delhi, Coastal Zone regulations, National Building Code 3, Fire Safety rules, some State DM acts like Bihar Disaster Management Act 2005, Uttarakhand Disaster Mitigation, Management and Prevention Act 2005 etc. also came into being.

1.9. Over the past few years, the Government of India have brought about a ***Paradigm Shift*** in the approach to Disaster Management, from the hitherto relief – centric outlook to a holistic perspective. The new approach precedes, from the conviction that development cannot be sustainable unless disaster mitigation is built into the development process. Towards this shift the GoI's new approach encompasses Prevention, Preparedness, Respond, Relief and Rehabilitation.

Statement of the Problem

1.10. The loss of human lives and property caused by Disasters are assuming

staggering proportions. The devastating cyclones in Andhra Pradesh in 1977 and 1996, Tsunami in 2004, earthquakes in J&K and Gujarat, numerous floods in Odisha, Kerala, Andhra Pradesh, TN, Gujarat, Mumbai, Uttarakhand and Assam and famines/drought in Rajasthan are the grim reminders to our National planners. Past few years have seen a proactive approach by Govt of India in evolving an elaborate Disaster Management framework. This study will carry out an analysis to evaluate evolving structures for management of disasters and role of **Armed Forces** with an aim to recommend value addition in terms of more ***Effective Integration*** of ***Armed Forces*** with ***State & Central Organisations*** in Disaster Management apparatus.

1.11 There is also a need to examine the approach to Disaster Management in India with special focus on the use of ***Science & Technology***, ***Data Analytics, Artificial Intelligence*** and ***Knowledge Management*** for a more effective and responsive Disaster Management programs in India.

Research Objectives

1.12 It is a known fact that the Armed Forces in the past have rendered unrelenting services to the Nation in the field of disaster assistance and management, mostly as the first responder and bring relief to the affected people in every corner of the country. Ironically, most of this is not recorded well and even if documented, its access to the environment is restricted due to the secretive nature of the Armed Forces. It is only recently that the Armed Forces have realized the seriousness and significance of this important task being performed by them towards the Disaster Management process.

1.13 The objective of this dissertation is to study existing framework and approach to Disasters Management in India and identify the scope on the role of **Armed Forces** with special emphasis on application of Science & Technology, Artificial Intelligence, Big Data and Knowledge Management in evolving comprehensive plan

for an effective handling of Disaster Management in India. Derive Interpolation of strategies based on the above learning's and rollout suggestions / recommendations for ***effective emergency system and disaster response management processes*** to the government and the Armed Forces HQ**.**

Rationale / Justification

1.14 The losses to human lives, livestock, property and various economic losses affected by natural calamities every year are assuming overwhelming proportions. The destructions affected by various disasters have brought into spotlight the issues of management of natural disasters in our country. In spite of various legislations, provisions and policies in vogue, it appears that our think-tank at all levels have still not learnt their lessons.

1.15 The Armed Forces of any country are perhaps the best suited, organised, administered and well managed force to be the first responders and provide assistance to a full range of reliefs such as rapid transport, communications, health, sanitation and emergency medical care, rescue and support activities during any kind disaster situations. They are a quick reaction force who can respond rapidly in a fully self-contained, self-sufficient and in a most versatile approach. Experience shows that the Armed Forces personnel are experts, unique and distinct in their individual skills necessary to perform their professional and functional activities and are rational in collaboration and coordinated action under an integrated, dynamic and flexible disaster situation and achieve an ***Effective & Efficient Disaster Management*** in a multi-agency environment. Therefore, the Government has an additional instrument available in the form of the Armed Forces for speedy and effective delivery of emergency assistance.

1.16 A few queries that surface are; what is the role of the Armed Forces in disaster management? Are the Defence Forces sufficiently geared up to meet future

challenges? Is the training given to their personnel is adequate to respond efficiently to a disaster situations? Is there a genuine necessity for the deployment of Armed Forces, now that the NDMA is fully raised, functional and operational?

Hypothesis

1.17 The Government's effort in evolving a comprehensive frame work of disaster Management suffers from rigid approach. There is a need to correctly appreciate the role of ***Armed Forces*** in ***Disaster Management***, for their effective integration into evolving frame work and use the tools of **Science & Technology, Geoinformatics, Artificial Intelligence** and ***Data Analytics*** in optimizing the Disaster Management process as a whole.

Scope and Limitation of the Study

1.18 The subject matter is discussed in sufficient detail to analyze the existing mechanism and suggest changes for improvement. However, study has following limitations:-

(i) Disaster relief and management procedures and management procedures and organizations differ from State to State and cannot be covered in its entirety.

(ii) Focus of the dissertation is primarily on disasters caused by natural hazards and the study will be India specific.

(iii) Study is limited only to Cyclones, Earthquakes and Tsunami, that occurred in India.

Research Design

1.19 Keeping in view the challenges in research methodology and the principals to study the ***relative performanc***e of various stakeholders vis-à-vis the Armed Forces in crisis and disaster response management in the dynamics of Government domain, a research design is presented in this dissertation. This includes design of the research questions, concerns to be addressed, scope of the research and limitations of the

research, research model and methodologies to be employed.

Research Questions

1.20 Having had a clear idea as to the requirement for the research on the subject, it is feasible to outline the specific research questions. The framework, which encourages the research questions along with the specific research questions are given in the table given below. This is used predominantly for collecting data relating to the extent and effectiveness of managing Situation at the time of Disaster and situation post Disaster that is, aspects pertaining to rescue, relief, rehabilitation works. This questionnaire is primarily targeted the government officials involved with DM process both from Central and the State, members of the academia, senior officers from the Armed Forces and few NGOs.

Sl No	Area of Concern	Questions
01	Disaster Relief Operation	(i) Participation in Disaster Relief Operations (ii) Association with planning of Operations (iii) Deployment of Armed Forces (iv) Coordination between various stakeholders
02	Aid to Civil	(i) Pre disaster deployment of Armed Forces (ii) Frequency of Armed Forces Deployment (iii) Effect on Armed Forces Resources
03	Training and Disaster Response	(i) Periodicity of Mock drills (ii) Work load of Armed Forces during Joint Exercises (iii) Trend of utilization of Armed Forces towards Disaster Response (iv) Utilisation of Armed Forces Equipment (v) Impact on serviceability of equipment during disaster relief Operations (vi) Role of Armed Forces vis-a-vis NDRF (vii) Dedicated Disaster Relief Equipment to

		Armed Forces
04	Effect on Armed Forces Preparation	(i) The effect on Armed Forces on their schedule planned exercises (ii) Effect on transfer of entitled ration to disaster operations
05	Duration of Deployment of Armed Forces	(i) Over Utilisation of Armed Forces (ii) Effect on Operational Preparedness (iii) Effect on combat training
06	Science and Technology	(i) Utilisation of various tools like **AI**, **BIGDATA** and **GEO INFORMATICS** (ii) Competency of Handling these tools

Table 1.2

Notes: - The mentioned questions as per Column-3 pertaining to the Concerns of Column-2 were appropriately designed to obtain the response from the environment (Analysis of the questionnaire is covered in the ***Chapter VIII*** and sample questions is placed as ***Annexure*** to the dissertation)

Methodology and Data Sources

1.21 Statistics, data and information have been collated and compiled from archived files, books, journals and newspapers from various libraries, reference centres and open source data banks of the Indian Army, Indian Air Force and the Indian Navy. Some statistics, figures and historical data were also referred and acquired from various ***World Wide Web*** sites, internet and digital archives. The researcher was also involved in flood & cyclone relief operations in Assam, Gujarat and Uttarakhand and many other small scale disaster situations during the past three decades and accordingly, personal involvement and material evidence obtained during these are also included. The collation, synthesis and analysis of various sources of information were further corroborated by interaction with various government officials, domain experts in the field and agencies having experience in handling and monitoring disaster situations.

1.22 The study covers following major issues:-

(i) General Introduction to various forms of Natural Disasters and their impact

on the nation building.

(ii) Current Disaster Management perspective in India.

(iii) Action Plan of Govt of India.

(iv) Scope of Science & Info Technology, Data Analytics, Artificial Intelligence and knowledge management, including the various tools of Science and Technology in evolving comprehensive disaster mitigation plans.

(v) Challenges and risks in India's disaster scenario.

(vi) Existing National response structures.

(vii) Institutional and legal framework for managing disasters.

(viii) Case Studies of Bhuj earthquake in 2001, Indian Ocean Tsunami 2004 and Cyclone Fani in 2019.

(ix) Role and organisation of the Armed Forces in disaster management, and coordination of military assistance.

(x) Recommendations for adopting a coherent strategy for the future.

CHAPTER - II

DISASTERS AND THEIR IMPACT ON THE NATION

2.1 **Disaster.** The term, 'hazards' very often is used inter-changeably, but its implication and consequences are distinct. The concise Oxford Dictionary defines disaster as *"**sudden or great misfortune; calamity or complete failure**"*. The World Health Organisation defines ***Disaster as any occurrence disrupting the normal conditions of existence and causing a level of suffering that exceeds the capacity of adjustments of the affected community***[7]**.** The term '***Disaster'*** arouses remarkable response from the outside the community or affected area from across the geographical locations. Disaster is all about vulnerability, exposure of a potential victim to the life endangering impact of a disaster. The revised terminology of the United Nations Office for Disaster Risk Reduction (UNISDR) defines '**Disaster'** as ***"A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts." (UNISDR 2016)***[8]

2.2 **Disaster Preparedness.** It may be described as action designed to lessen the loss of life and damage, and to organize and facilitate timely and effective rescue, relief and rehabilitation in cases of disaster. Preparedness is supported by the required legislation and means a readiness to deal with disaster situations.

2.3 **Disaster Prevention.** It may be described as measures designed to prevent natural phenomenon from causing or resulting in disasters or other related emergency situations. Prevention concerns the formulation and implementation of Long-range / Long term policies and programs to prevent, minimize or eliminate

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[7] *Disaster Emergencies-WHO/EHA Panafrican emergency training center Addis Ababa 2002, pg 3*

[8] *National Disaster Management Plan, 2019. A publication of the National Disaster Management Authority, Government of India.*
November 2019, New Delhi. Para 1.1, Pp 35

the occurrence of disasters.

Type of Disasters

2.4 A wide range of forces can cause disasters. These forces may be either natural or man-made or combination of both.

2.5 **Man-made Disasters.** Within this category of disasters, there are a variety of conditions resulting disaster: -

(i) **Civil Disturbances.** Riots. e.g.: Bombay Riots of 1992, Riots in Delhi 2019-20.

(ii) **Warfare.** Conventional, NBC warfare, LICO, terrorism, and mass movement of people from one place to another.

(iii) **Refugees.** Forced movements of large numbers of people, usually across frontiers; example: refugees of Rwanda, Myanmar, Syria and in Zaire.

(iv) **Accidents.** Collapse of buildings/roads/bridges, mine disasters, bridges, Road / Rail accidents, Industrial disasters like Bhopal Gas Tragedy of 1994 in India.

2.6 **Natural Disasters.** Within this category of disasters, a variety of forces that may result in disaster: -

(i) **Meteorological Disasters.** Cyclones, hurricanes, cold wave, heat wave and droughts (possibly causing famines).

(ii) **Topological Disasters.** Earthquakes, Tsunamis, Avalanches, Landslides, and Floods.

(iii) **Biological Disasters.** Epidemics/Pandemic of communicable diseases; example - Plague in Surat, Malaria in Rajasthan, swine flu and dengue in some of the States in the recent past and most importantly, the onset of Novel Corona / Covid 19 type of **Pandemic** in China, Italy, Germany and in many countries that we should be guarding against.

2.7 **Floods.** India has always been devastated by floods. This is a seasonal and endemic term of disaster, which causes great havoc and devastation every year. The primary cause of all floods in India is heavy and concentrated rainfall, which is nearly 75% of the rainfall, occurs over a short Monsoon period between June and September and is the rainiest period of the year. Nearly 12% of the land mass is affected by the floods. Rainfall also occurs from October to December in East Coast of Southern Peninsula due to North East Monsoons.

2.8 **Cyclones.** The major natural disasters that affect the coastal regions of India are cyclones and with more than 7500 kms of coastline, India is affected by nearly 10 percent of the world's tropical cyclones. About 71 percent of this area is in ten States (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Puducherry, Andhra Pradesh, Odisha and West Bengal). The islands of Andaman & Nicobar and Lakshadweep are equally vulnerable to cyclones. On an average, around five to six tropical cyclones are generally formed in the Bay of Bengal and Arabian Sea coasts every year. Out of these, two to three are severe. A cyclone is a violent windstorm, usually accompanied by much rain, squall, thunder, hail and lightning. When a cyclone approaches the coast, a risk of serious loss or damage arises from severe winds heavy rainfall, storm surges and river floods. The effect of a storm flow is most evident in wide and shallow bays exposed to cyclones such as in the northern part of Bay of Bengal. The occurrences of cyclones are concentrated in the Bay of Bengal followed by those in the Arabian Sea and the ratio is approximately 4:1. The incidence of cyclonic storms, with wind speeds between 65 km/h and 117 km/h and severe cyclonic storm with wind speeds gusting between 119 km/h and 164km/h, reaching Tamil Nadu and Andhra Pradesh is high during the north east monsoon season i.e., October – December, whereas the highest annual number of storms, severe storms occur in the Odisha - West Bengal coast.

2.9 In the Bay of Bengal, these normally occur from December to March. The coastal areas and areas up to few hundred kilometers in land are more vulnerable to cyclone havoc particularly the coasts of Orissa, Andhra Pradesh, Gujarat and Tamil Nadu.

2.10 Globally, earthquakes result in a loss of about 50,000 lives every year. Earthquakes over 5.5 magnitudes on the Richter are progressively damaging to property and human life. Though, there are many other factors that influence the damage pattern, but gigantic earthquakes generally occur near the junction of two tectonic plates, e.g., along the Himalayan range, where the Indian plate goes below Eurasian plate. The Indian sub-continent situated on the boundaries of two continental plates is extremely susceptible to earthquakes. Some of the foremost intense earthquakes of the planet have occurred in India. Fortunately, none of those have occurred in any of the main cities. India has some of the highly populous cities in the world; however, the constructions in these cities aren't earthquake resistant, thereby posing much more danger during calamities. Regulatory mechanisms are weak, thus any earthquake striking in any of these cities would turn into a major disaster leading to catastrophe. Five major earthquakes have struck different parts of India over a span of the last 15 years leading to colossal economic and human losses.

2.11 The entire Himalayan Region is regarded as vulnerable to high intensity earthquakes of a magnitude exceeding 8.0 on the Richter Scale, and during a relatively short span of about 50 years, four such major earthquakes have occurred in the region: Shillong 1897 (M 8.7); Kangra 1905 (M.8.0); Bihar–Nepal 1934 (M 8.3) and Assam-Tibet 1950 (M 8.6). Scientific publications have warned that very severe earthquakes are likely to occur anytime in the proximity of Himalayan Region, which could adversely affect the lives of several million people in India.

2.12 **Zoning for Earthquakes.** The three major types of earthquakes are volcanic, plutonic and tectonic, .the attributes of these are covered below: -

(i) **Volcanic**. It is attributable to volcanic activity usually centered near the volcano. Damage usually is limited and local.

(ii) **Plutonic.** These are deep focused quakes caused by explosion as deep as 435 miles within the interior of the earth. Though felt on the earth surface, little damage results except perhaps during a limited area directly above the explosion.

(iii) **Tectonic.** These earthquakes are most common and most destructive of all quakes. They are caused by slippage along faults in the earth's crust. The grating or rubbing together the sides of a fault set up earthquake waves.

2.13Earthquakes occur due to movements along faults that have evolved through geological and tectonic processes. The extent of the impact of an earthquake depends on its magnitude, location and time of occurrence. Geological Survey of India and India Meteorological Department are mainly monitoring the earthquake hazards of the country with NGRI is the principal Advisory Institution on the earthquakes. **Bureau of Indian Standard (BIS) code IS: 1893 deals with the earthquake resistance design of various structures including structures for Power Plants, Buildings and Bridges etc**. As per the code, the country has been demarcated from the point of view of intensity of seismic loads in four Zones i.e. Zone-II to Zone-V. According to latest seismic zoning map brought out by the Bureau of Indian Standard, over 65 percent of the country is vulnerable to earthquake of intensity Modified Mercalli Intensity Scale (MSK) VII or more. The entire Himalayan Region is considered to be vulnerable to high intensity earthquakes of a magnitude exceeding 8.0 on the Richter scale; and in a relatively short span of about 50 years, four such major earthquakes have already occurred in the region.

Earth Quake Zones in India[9]

Seismic Zone	II	III	IV	V
Prob. Max. Intensities (MSK Scale)	IV Or Less	VII	VIII	IX Or More

Earth quake Zones in India		
Sl.No.	Zone	Region/States
1	Zone V (Highest Risk areas with intensity MSK IX or greater)	Kashmir, the western and central Himalayas, North Bihar, the North-East Indian region and the Rann of Kutch
2	Zone IV (High Risk areas liable to MSK VIII)	Indo-Gangetic basin including Delhi, Jammu and Kashmir, Parts of Maharashtra, Gujarat
3	Zone III (Moderate Damage Risk Zone which is liable to MSK VII)	Coastal Areas, Andaman and Nicobar Islands, Parts of Kashmir, Western Himalayas
4	Zone II (Low damage Risk zone liable to MSK VI or less)	Most of Deccan & Chota Nagpur Plateau, Rajasthan

Table 2.1
Source: Crisis & Disaster Management for Power Sector, Min of Power; Mar 2017

LIST OF IMPORTANT TOWNS FALLING IN SEISMIC ZONES II,III,IV AND V

Town	State/ UT	Zone	Town	State/UT	Zone	Town	State/ UT	Zone
Agra	UP	III	Delhi	Delhi	IV	Mandi	HP	V
Ahmedabad	Gujarat	III	Durgapur	West Bengal	III	Nasik	Maharashtra	III
Ajmer	Rajasthan	II	Gangtok	Sikkim	IV	Nellore	Andhra Pradesh	III
Allahadbad	UP	II	Guwahati	Assam	V	Osmanabad	Maharshtra	III
Almora	Uttara Khand	IV	Goa	Goa	III	Panjim	GOa	III
Ambala	Haryana	IV	Gulbarga	Karnataka	II	Patiala	Punjab	III
Amritsar	Punjab	IV	Gaya	Bihar	III	Patna	Bihar	IV
Asansol	West Bengal	III	Gorakhpur	UP	IV	Pilbhit	UP	IV

[9] Crisis & Disaster Management For Power Sector, Min Of Power; Mar 2017 Tsunamis

Aurangabad	Maharashtra	II	Hyderabad	AP/Telangana	II	Pondicherry	Tamilnadu	II
Baharich	UP	IV	Imphal	Manipur	V	Pune	Maharashtra	III
Bangalore	Karnataka	II	Jabalpur	Madhya Pradesh	III	Raipur	Chandigarh	II
Barauni	Bihar	IV	Jaipur	Rajasthan	II	Rajkot	Gujarat	III
Bareilly	UP	III	Jamshedpur	Jharkhand	II	Ranchi	Chattisgarh	II
Belgaum	Karnataka	III	Jhansi	UP	II	Roorkee	Uttrakhand	IV
Bhatinda	Punjab	III	Jodhpur	Rajasthan	II	Rourkela	Orissa	II
Bhilal	Chattisgarh	II	Jorhat	Assam	V	Sadiya	Assam	V
Bhopal	MP	II	Kakarapara	Gujarat	III	Salem	Tamilnadu	III
Bhubaneswar	Orissa	III	Kalpakkam	Tamilnadu	III	Simla	HP	IV
Bhuj	Gujarat	V	Kancheepuram	Tamilnadu	III	Sironk	MP	II
Bijapur	Karnataka	III	Kanpur	UP	III	Solapur	Maharashtra	III
Bikaner	Rajasthan	III	Kanwar	Karnataka	III	Srinagar	J&K	V
Bokaro	Jharkhand	III	Kohima	Nagaland	V	Surat	Gujarat	III
Bulandshahr	UP	IV	Kolkata	West Bengal	III	Tarapur	Maharashtra	III
Burdwan	West Bengal	III	Kota	Rajasthan	II	Tezpur	Assam	V
Calicut	Kerala	III	Kurnool	West Bengal	II	Thane	Maharashtra	III
Chandigarh	Tamil Nadu	IV	Lucknow	UP	III	Thiruvananthapuram	Kerala	III
Chennai	Tamilnadu	III	Ludhiana	Punab	IV	Tiruchirapalli	Tamilnadu	II
Chitradurga	Karnataka	II	Madurai	Tamilnadu	II	Tiruvannamalai	Tamilnadu	III
Coimbatore	Tamilnadu	III	Mangalore	Karnataka	III	Udaipur	Rahasthan	II

Cuddalore	Tamilnadu	III	Monghyr	Bihar	IV	Vadodara	Gujarat	III
Cuttack	Orissa	III	Moradabad	UP	IV	Varanasi	Uttar Pradesh	III
Darjeeling	West Bengal	IV	Mumbai	Maharashtra	III	Vellore	Tamilnadu	III
Dharwad	Karnataka	III	Mysore	Karnataka	II	Vijayawada	Andhra Pradesh	III
Dehradun	Uttara Khand	IV	Nagpur	Maharashtra	II	Vishakapatnam	Andhra Pradesh	II
Dharmapuri	Tamilnadu	II	Nagarjunasagar	Telangana	II			
Darbhanga	Bihar	V	Nainital	Uttrakhand	IV			

Table 2.2

Source: EARTHQUAKE PRONE STATES: GoI, Min of Earth Sciences Lok Sabha Un-starred Question No. 1780 Answered on Wednesday, 26 July 2017

*Map Showing the Seismic zones in India.

Fig 2.1

Source: Maps of India 2017

Tsunamis

2.14 **Tsunamis** and earthquakes happen after centuries of energy build up within the earth. A Tsunami (in Japanese ***'tsu'*** means ***harbour*** and ***'nami'*** means ***wave; i.e., "Harbour Wave"***) is a series of water waves caused by the displacement of a large volume of body of water, usually an ocean. Seismicity generated Tsunamis are result of abrupt deformation of sea floor resulting vertical displacement of the

overlying water thereby accumulating huge amounts of energy. For earthquakes occurring beneath the sea level, the water above the reformed area is displaced from its equilibrium position. The release of energy produces giant Tsunami waves which have small amplitude but a very long wavelength (often hundreds of kilometer long). It may be caused by non-seismic event also such as a landslide, breaking of glaciers or impact of a meteor or Asteroid on to the sea.

2.15 **Tsunami Zoning.** Tsunami in the deep ocean may have very long wavelength of hundreds of kilometer and travels at about 800 km per hour, but amplitude of only about 1 km. It remains undetected by ships in the deep sea. However, when it approaches the coast its wavelength diminishes but amplitude grows enormously, and it takes little or no time to arrive its full height. Tsunamis have great erosion potential, stripping beaches of sand, coastal vegetation and dissipating its energy through the destruction of homes and coastal structures. Potential Tsunami genic zones may be seen from Figure below. For Tsunami to hit the Indian coast according to INCOIS (Indian National Centre for Ocean Information Services), it is necessary that the earthquake of magnitude more than 7.0 on Richter scale should normally occur. The possible zones for such an occurrence are Andaman - Sumatra or Makran (Pakistan) belt. Not all the major earthquakes are Tsunami genic; however, technically, all the coastal regions can be affected by Tsunamis.

2.16 **Indian Ocean Tsunami Warning & Mitigation System (IOT WS).** In less than three months following the devastating Indian Ocean Tsunami, scientists worked together with policy makers to form an international commitment to develop an Indian Ocean Tsunami Warning & Mitigation System (IOT WS). The IOT WS is now fully operational, comprising a set of Regional Tsunami Service Providers (India, Australia, and Indonesia) issuing Tsunami advisories to all National Tsunami

Warning Centre of the Indian Ocean rim countries. The IOTWS also developed the initial international guidelines for Tsunami hazard and risk assessment. The most heavily affected nations of Indonesia, Sri Lanka and India developed new disaster management policy frameworks, governance structures and national disaster management plans to deal with Tsunami and other natural disaster risks. For instance, the Indonesian Government developed the Presidential Tsunami Master Plan for Reducing Tsunami Risk which is underpinned by national-scale Tsunami hazard mapping to establish determine shelters and strengthen warning systems for at risk coastal communities. The IOTWS now provides warnings to all the Indian Ocean country members, reaching lakhs of people that had no warnings in 2004. Furthermore, Tsunami hazard mapping and evacuation planning has been administered for many coastal communities today.

Effects of Disaster

2.17**General**. While each disaster has its own characteristics, it is possible to determine a common base of disaster effect. This is necessary to evolve common disaster relief / management operations to combat their effects[10]. Natural hazards fall under four main categories depending upon the driving forces of the event; geological hazards, atmospheric hazards, hydrological hazards, and biological hazards.

(i) **Geological hazards** occur because of geological processes such as movement in the tectonic plates and volcanic activity. These events include earthquakes, volcanic eruptions, and landslides.

[10] Defense Services Staff College (DSSC) Handout- Disaster Relief. pp 7

(ii) **Meteorological hazards** occur as a result of processes in the atmosphere. Meteorological hazards include extreme temperatures, Cyclones, hurricanes, tornadoes, droughts, and severe storms.

(iii) **Hydrological hazards** are hazards involving water processes. Examples include floods, droughts, and Tsunamis.

(iv) **Biological hazards** occur due to the biological processes of the earth and primarily involve the spread of diseases and pests. Epidemics, pandemics and insect swarms all come under the biological hazards category.

2.18 Sometimes, natural hazards can fit into more than one category. For example, an earthquake in the middle of the ocean can also cause a Tsunami; this would be a geological and a hydrological disaster because the earthquake (a geological event) caused the Tsunami (a hydrological event). Another example is when a volcanic eruption (a geological event) spews ash and dust into the atmosphere to cause lower temperatures (a meteorological event). Natural hazards also fit into three categories that describe the speed and extent of a hazard: catastrophic hazards, rapid onset hazards, and slow onset hazards.

(i) **Catastrophic hazards** are large-scale that effect large numbers of people or have worldwide effects. Pandemics, large volcanic eruptions, and worldwide droughts are all illustrations of catastrophic natural hazards.

(ii) **Rapid onset hazards** occur quickly and with little warning. Volcanic eruptions, earthquakes, flash floods, and landslides are examples of rapid onset hazards.

(iii) **Slow onset hazards** occur slowly and may take years to develop. Epidemics, insect infestations, and droughts are all slow onset hazards.

2.19 **Effects.** The effects of natural disasters are many and varied. Some are short term effects which can be fixed with relative ease while others last for years. Natural

disasters have three general categories of effects; that are - primary effects, secondary effects, and tertiary effects.

(i) Primary effects are the direct result of the natural disaster, such as collapsed buildings and water damage.

(ii) Secondary effects are the result of primary effects. Examples of secondary effects include power breakdown due to fallen trees or damaged building and fires from broken gas lines.

(iii) Tertiary effects are the long term effects of natural disasters. These include changes within the landscape and natural features, loss of habitat, and crop failure or reduction owing to cooler temperatures or other interference.

2.20To sum up, the following are the effects of Natural Disasters:-

(i) Mass Deaths and Danger to Life.

(ii) Destruction and Damage to Buildings, Hangars, Roads, Airports & Railways.

(iii) Lack of Water, contamination of Water Source, shortage of Food and Essential Requirements.

(iv) Disruption to Communication and Power lines.

(v) Outbreak or Danger of Epidemics.

(vi) Threat to Crops & Livestock, Vital Installations, Public Utilities or Fire Hazards.

(vii) Panic, anxiety and psychological disorders.

2.21**India's Vulnerability to Disasters.** India extends from snow covered Himalayas to tropical rain forest of the south and the deserts in the North West Rajasthan. Unique geo-climatic conditions of the Indian subcontinent make this region amongst the most vulnerable to natural disasters in the world. India is highly vulnerable to drought, floods, cyclones and earthquakes. Landslides,

avalanches and bush fires too frequently occur in the Himalayan region. Almost all our 28 States and 11 UTs are highly disaster prone[11]. A few major disasters worth mention are:-

(i) Flash floods due to cloud burst at Kulu-Manali, Sirsa, Leh and Kedarnath.

(ii) Gujarat, Andhra and Orissa Cyclones.

(iii) Malpa landslide in Utharakand in 1998.

(iv) Floods in TN, Kodugu, Mumbai, Vadodara, Uttarakhand, Bihar, AP and Assam.

(v) Latur, Bhuj, J&K & Sikkim Earthquakes.

(vi) Tsunami in 2004.

2.22From heat waves to flash floods, India has witnessed extreme weather conditions this year. While parts of northern and southern India were struggling with drought-like conditions during summer, the Northeast and western coastal areas have been battered with torrential downpour lately. Successive disasters have compelled us to draw our attention to the million-dollar question: "Has climate crisis hit home? According to weather website **El Dorado**[12], out of the 15 places that have received most rainfall across the globe in the last one year, eight are in India. Recently, the same weather listing source had counted four places in India among the world's hottest 15 places.

[11] *Professor Vinod K. Sharma.' India Disaster Management Profile.' Pp 1*

[12] *https://www.eldoradoweather.com/climate/world-extremes/world-temp-rainfall-extremes.php*

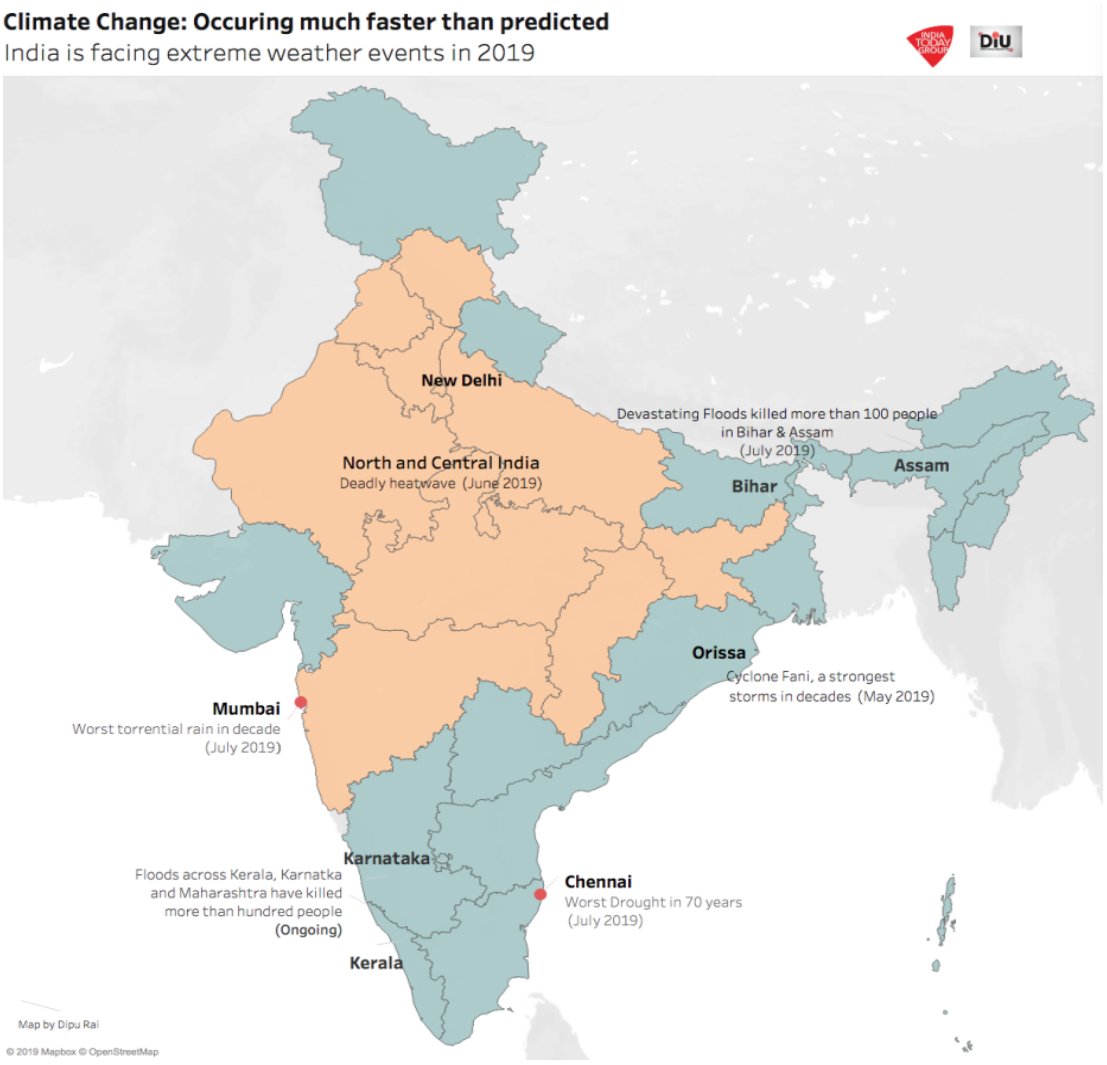

Fig 2.2

2.23. **Losses Due to Disasters.** There have been colossal losses due to disasters in India. During the last 80 years, India has lost about 70,000 lives due to the earthquakes alone, at an average of about 900 lives per year. India is one of the most affected countries in the world having suffered huge losses of humans, livestock and causing huge impact on the national economy.

Special Features of Disaster Management

2.24. Special features of disaster management are as follows:[13]

(i) **Lack of Early Warning and Geospatial Information.** This results in

[13] Defense Services Staff College Op. cit. pp. 8

delayed response due to lack of relief intelligence.

(ii) **Inadequate Resources.** Mobilisation of resources in men and material from multiple sources is a critical planning and organisational problem.

(iii) **Varying Requirements.** Each disaster situation requires separate consideration, planning and expertise to deal with its peculiar and region specific problems.

Stages of Disaster Management

2.25 Comprehensive disaster management, which involves both assessment and response, can be seen to involve three chronological stages, although stages overlap. These phases are seldom readily separable but need to be determined as part of disaster management process.

(i) **Preparatory Stage.** This corresponds to the pre-disaster period and will include disaster prediction & forecasting state, warning and alert system, preventive measures, and issue contingency plans. It will mainly involve governmental agencies.

(ii) **Emergency/Response Stage.** This stage commences after the disaster strikes and immediately before it including reaction to warnings and emergency relief activities.

(iii) **Rehabilitation and Reconstruction Stage.** Covers short and long term measures to restore essential services, communication and normal community life. Rehabilitation phase involves many succeeding weeks or months, while reconstruction may take even longer times, often years.

2.26 **Stages in the Progressive Restoration of Normality.** The models given in figures give out progressive restoration of normal situation in relation to time

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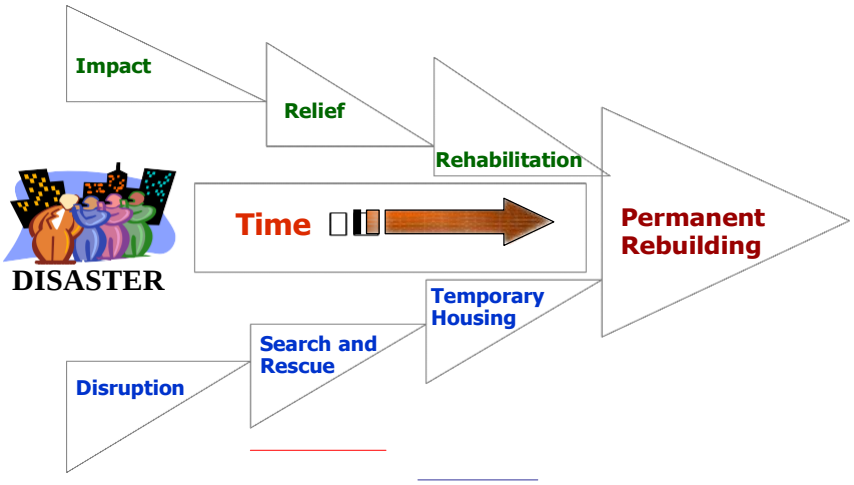
Impact
Relief
Rehabilitation
Time
Permanent Rebuilding
DISASTER
Temporary Housing
Search and Rescue
Disruption

Fig 2.3

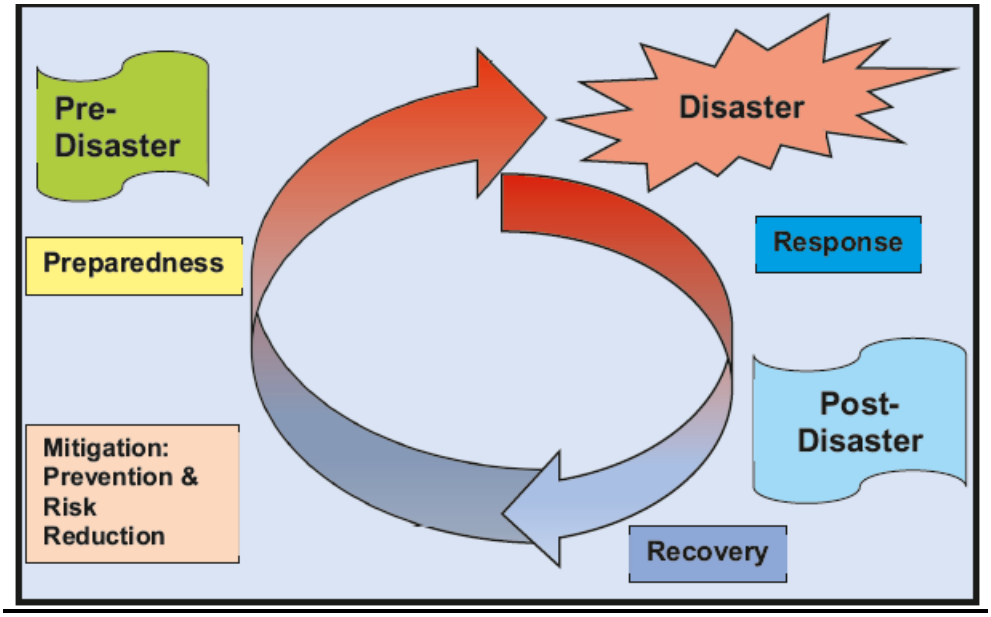
Pre-Disaster
Disaster
Response
Preparedness
Post-Disaster
Mitigation: Prevention & Risk Reduction
Recovery

Fig 2.4

DISASTER MANAGEMENT CYCLE[14]

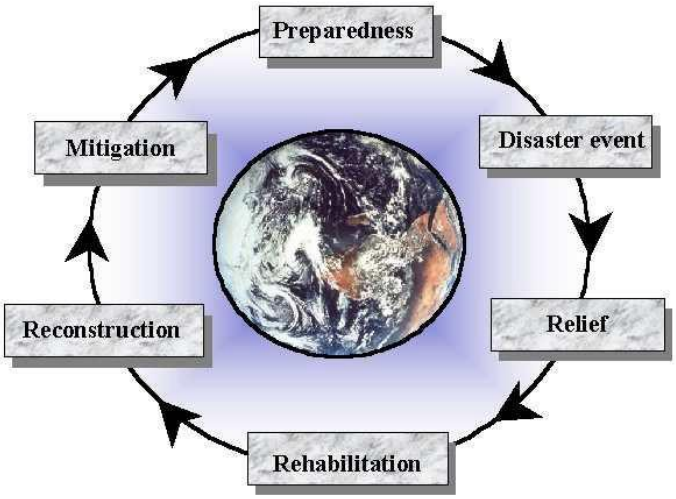

Fig 2.5

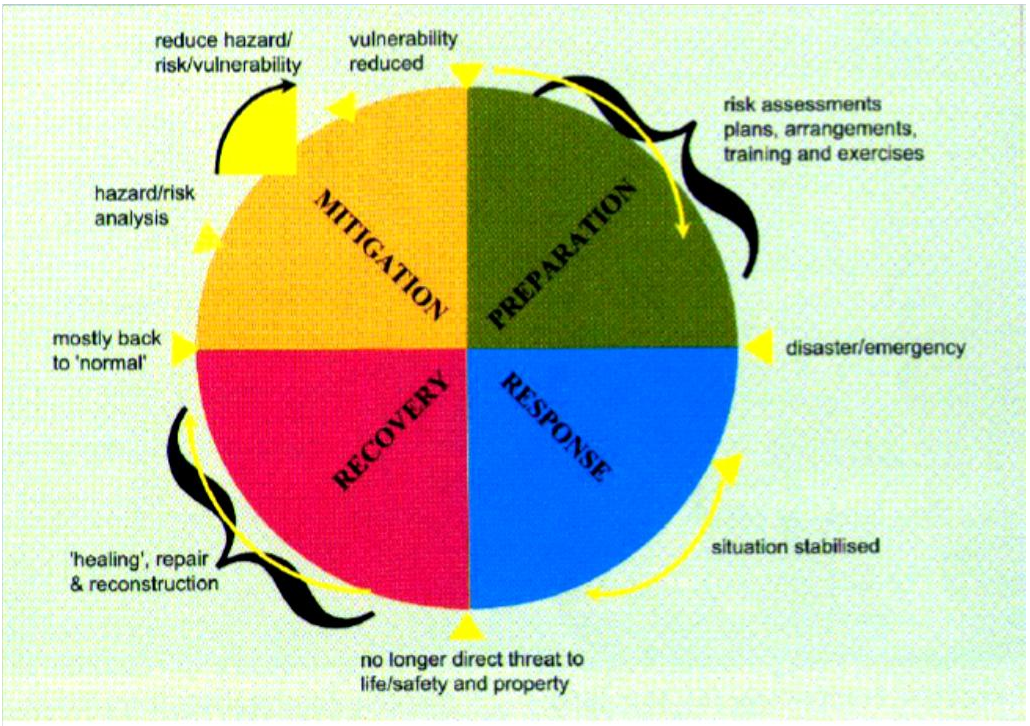

Fig 2.6

SOURCE: CRISIS & DISASTER MANAGEMENT FOR POWER SECTOR, MIN OF POWER; MAR 2017

[14] *National Disaster Management Plan, 2019. A publication of the National Disaster Management Authority, Government of India. November 2019, New Delhi Para 1.1 Pp36*

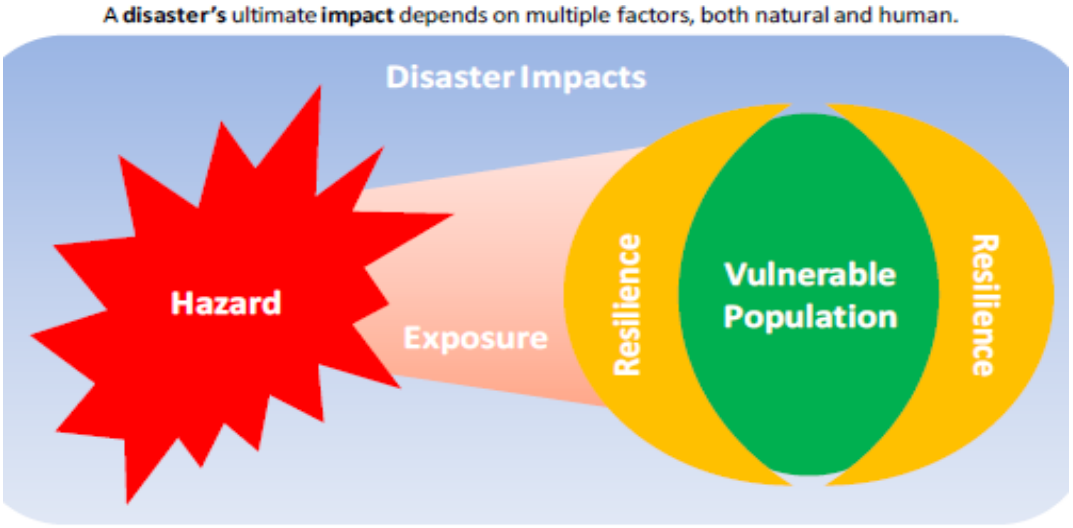

Fig-2.7[15]

[15] Source: Crisis & Disaster Management for Power Sector, Min of Power; Mar 2017

CHAPTER - III

DISASTER MANAGEMENT FRAMEWORK IN INDIA

To understand is hard. Once one understands, action is easy.

Sun Yat-Sen

General

3.1 The Disaster Management framework in India has evolved over a period of time quite effectively. Currently, the initial responder to provide relief in the wake of natural disasters is that of the **State Governments.** The Min of Home Affairs at Center is the nodal agency responsible for Disaster Management in India. Since early 2000, the Government has been focusing on developing the capacities in the country for preparedness, prevention and mitigation along with developing capacities for response within the country. The need to eliminate the underlying vulnerabilities through systematic integration and developing of various disaster risks reduction programmes is being undertaken by the GoI. Achieving the India's development goal and sustainable development are not possible unless the Government ensures that all developments are disaster resilient. This would entail, putting in place ***legal instruments, appropriate Institutional arrangements, building capacities*** at all levels to carry out a variety of risk reduction measures and developing appropriate tools and guidelines. Simultaneously, the Center's role is also to provide resources to the States activities and augment the specialist manpower for this purpose and acting in a supportive manner in relation to economic activities and infrastructure mobilisation. The proportions of the **responses by the Central Government** are determined in accordance with the current policy of financing the relief expenditure and keeping in view the factors like: -

(i) The **severity** of the calamity.

(ii) The **scale** of the relief operation necessitating the relief.

(iii) The requirement of Central assistance to augment the **Financial Resources** at the disposal of the State government, based on the estimated losses/damages.

Institutional and Legal Arrangement

3.2 **Disaster Management Act 2005.** The Act lays down ***institutional***, ***legal***, ***financial*** and ***coordination mechanism*** along with ***powers of punishment*** at the National State, District and Local levels. These Institutions are expected to work in close Harmony with each other.

3.3 **National Disaster Management Authority (NDMA).** National Disaster Management Authority has been constituted at the National level in May 2005, as a constitutional provision under the Chairmanship of Prime Minister, and shall have the responsibility for laying down the policies, plans and guidelines for disaster management for ensuring timely and effective response to disaster. It is the Apex body in India to tackle all forms of disasters in India[16]. This Authority will be responsible for [17]:-

(i) Lay down policies on disaster management;

(ii) Approve the National Plan;

(iii) Approve plans prepared by the Ministries or Departments of the Government of India in accordance with the National Plan;

(iv) Lay down guidelines to be followed by the State Authorities in drawing up the State Plan;

[16] *Ref Sec 6 (1) of DM Act 2005*
[17] *Ref Sec 6 (2) of DM Act 2005*

(v) Lay down guidelines to be followed by the different Ministries or Departments of the Government of India for the purpose of integrating the measures for prevention of disaster or the mitigation of its effects in their development plans and projects;

(vi) Coordinate the enforcement and implementation of the policy and plan for disaster management;

(vii) Recommend provision of funds for the purpose of mitigation;

(viii) Provide such support to other countries affected by major disasters as may be determined by the Central Government;

(ix) Take such other measures for the prevention of disaster, or the mitigation, or preparedness and capacity building for dealing with the threatening disaster situation or disaster as it may consider necessary;

(x) Lay down broad policies and guidelines for the functioning of the National Institute of Disaster Management.

(xi) A continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary or expedient for the following:

(a) Prevention of danger or threat of any disaster,

(b) Mitigation or reduction of risk of any disaster or its severity or consequences,

(c) Capacity-building,

(d) Preparedness to deal with any disaster,

(e) Prompt response to any threatening disaster situation or disaster, Assessing

(f) The severity or magnitude of effects of any disaster

(g) Evacuation, rescue and relief, and

(h) Rehabilitation and reconstruction.

National Policy on Disaster Management (NPDM) 2009

3.4. Approved by the Union Cabinet on 22nd October, 2009, the vision of this policy was to build a safe and disaster resilient India by developing a holistic, proactive, multi-disaster oriented and technology driven strategy through a culture of prevention, mitigation, preparedness and response. Together with DM Act 2005, NPDM established national practices. Relevant agencies; central or state will carry out disaster management activities in different phases in the disaster-affected areas depending on the type and scale of disaster. NPDM notes that while it is not possible to avoid natural hazards, adequate mitigation and disaster risk reduction measures can prevent the hazards becoming major disasters. Disaster risk arises when hazards interact with physical, social, economic and environmental vulnerabilities. The NPDM suggests a multi-pronged approach for disaster risk reduction and mitigation consisting of the following[18]:

(i) Integrating risk reduction measures into all development projects

(ii) Initiating mitigation projects in identified high priority areas through joint efforts of the Central and State Governments

(iii) Encouraging and assisting State level mitigation projects

(iv) Paying attention to indigenous knowledge on disaster and coping mechanisms

(v) Giving due weightage to the protection of heritage structures

[18] *National Disaster Management Plan, 2019. A publication of the National Disaster Management Authority, Government of India. November 2019, New Delhi*

3.5. **Objectives of NPDM[19].** The objectives of the National Policy on Disaster Management are:

(i) Promoting a culture of prevention, preparedness and resilience at all levels through knowledge, innovation and education.

(ii) Encouraging mitigation measures based on technology, traditional wisdom and environmental sustainability.

(iii) Mainstreaming disaster management into the developmental planning process.

(iv) Establishing institutional and techno-legal frameworks to create an enabling regulatory environment and a compliance regime.

(v) Ensuring efficient mechanism for identification, assessment and monitoring of disaster risks.

(vi) Developing contemporary forecasting and early warning systems backed by responsive and fail-safe communication with information technology support.

(vii) Ensuring efficient response and relief with a caring approach towards the needs of the vulnerable sections of the society.

(viii) Undertaking reconstruction as an opportunity to build disaster resilient structures and habitat for ensuring safer living.

(ix) Promoting a productive and proactive partnership with the media for disaster management.

3.6 **The National Executive Committee (NEC).** NEC has been constituted in the Cabinet Secretariat under Sec 8 of the DM Act 2005. The Chairperson of the Committee is the Union Home Secretary with Secys of GoI in the Depts of Agriculture

[19] *National Policy on Disaster Management 2009 Pp 2.4.1 pg 20*

space, Power, Telecommunications, Defence, HRD etc are either the Members or Special invitees. Their mandate is to prepare National Plan based on the National Policy on the Subject and perform any other function as prescribed by the GoI. Following are the **Powers and Functions of NEC**[20]**:-**

(i) **Sec 10 (1) :** The National Executive Committee shall assist the National Authority in the discharge of its functions and have the responsibility for implementing the policies and plans of the National Authority and ensure the compliance of directions issued by the Central Government for the purpose of disaster management in the country.

(ii) **Sec 10 (2) :** Without prejudice to the generality of the provisions contained in sub-section (*1*), the National Executive Committee may:-

(a) Act as the coordinating and monitoring body for disaster management;

(b) Prepare the National Plan to be approved by the National Authority;

(c) Coordinate and monitor the implementation of the National Policy;

(d) Lay down guidelines for preparing disaster management plans by different Ministries or Departments of the Government of India and the State Authorities;

(e) Provide necessary technical assistance to the State Governments and the State Authorities for preparing their disaster management plans in accordance with the guidelines laid down by the National Authority;

(f) Monitor the implementation of the National Plan and the plans prepared by the Ministries or Departments of the Government of India;

[20] *Ref Sec 10 of DM Act 2005*

(g) Monitor the implementation of the guidelines laid down by the National Authority for integrating of measures for prevention of disasters and mitigation by the Ministries or Departments in their development plans and projects;

(h) Monitor, coordinate and give directions regarding the mitigation and preparedness measures to be taken by different Ministries or Departments and agencies of the Government;

(i) Evaluate the preparedness at all governmental levels for the purpose of responding to any threatening disaster situation or disaster and give directions, where necessary, for enhancing such preparedness;

(j) Plan and coordinate specialised training programme for disaster management for different levels of officers, employees and voluntary rescue workers;

(k) Coordinate response in the event of any threatening disaster situation or disaster;

(l) Lay down guidelines for, or give directions to, the concerned Ministries or Departments of the Government of India, the State Governments and the State Authorities regarding measures to be taken by them in response to any threatening disaster situation or disaster;

(m) Require any department or agency of the Government to make available to the National Authority or State Authorities such men or material resources as are available with it for the purposes of emergency response, rescue and relief;

(n) Advise, assist and coordinate the activities of the Ministries or Departments of the Government of India, State Authorities, statutory bodies, other

governmental or non-governmental organisations and others engaged in disaster management;

(o) Provide necessary technical assistance or give advice to the State Authorities and District Authorities for carrying out their functions under this Act;

(p) Promote general education and awareness in relation to disaster management; and

(q) Perform such other functions as the National Authority may require it to perform.

3.7 **National Plan[21]. As per the Sec 11 of the DM Act 2005,** there shall be drawn up a plan for disaster management for the whole of the country to be called the National Plan. The National Plan shall be prepared by the National Executive Committee having regard to the National Policy and in consultation with the State Governments and expert bodies or organisations in the field of disaster management to be approved by the National Authority. The National Plan shall include:-

(i) Measures to be taken for the prevention of disasters, or the mitigation of their effects;

(ii) Measures to be taken for the integration of mitigation measures in the development plans;

(iii) Measures to be taken for preparedness and capacity building to effectively respond to any threatening disaster situations or disaster;

(iv) Roles and responsibilities of different Ministries or Departments of the Government of India in respect of measures specified in clauses (*a*), (*b*) and (*c*).

(v) Sec 11(4) : The National Plan shall be reviewed and updated annually.

[21] *Ref Sec 11 of DM Act 2005*

(vi) Sec 11(5) : Appropriate provisions shall be made by the Central Government for financing the measures to be carried out under the National Plan.

(vii) Sec 11(6) : Copies of the National Plan referred to in sub-sections (*2*) and (*4*) shall be made available to the Ministries or Departments of the Government of India and such Ministries or Departments shall draw up their own plans in accordance with the National Plan.

3.8 **State Disaster Management Authority (SDMA).** It's a statutory requirement under the DM Act to establish a SDMA at all the States and UTs. At the State/UT level, Chief Minister/LG as ex officio Chairperson, will lay down the policies and plans for **DM** according to the guidelines issued by the NDMA. This authority is expected to work in close harmony with the National Agencies. Subject to the provisions of the DM Act, **Powers and functions of State Authority are[22]; Sec 18 (1) of** DM Act stipulates that "Subject to the provisions of this Act, a State Authority shall have the responsibility for laying down policies and plans for disaster management in the State". Further, **Sec 18 (2)** of DM Act stipulates that without prejudice to the generality of provisions contained in sub-section (*1*), the State Authority may—

(i) Lay down the State disaster management policy;

(ii) Approve the State Plan in accordance with the guidelines laid down by the National Authority;

(iii) Approve the disaster management plans prepared by the departments of the Government of the State;

(iv) Lay down guidelines to be followed by the departments of the Government of the State for the purposes of integration of measures for prevention of disasters

[22] *Ref Sec 18 of DM Act 2005*

and mitigation in their development plans and projects and provide necessary technical assistance therefor;

(v) Coordinate the implementation of the State Plan;

(vi) Recommend provision of funds for mitigation and preparedness measures;

(vii) Review the development plans of the different departments of the State and ensure that prevention and mitigation measures are integrated therein;

(viii) Review the measures being taken for mitigation, capacity building and preparedness by the departments of the Government of the State and issue such guidelines as may be necessary.

3.9 **District Disaster Management Authority (DDMA).** It's a statutory requirement under the DM Act to establish a DDMA at all the States and UTs. The **DDMA** is headed by the District Collector / Dist Magistrate or Commissioner with elected members of the local bodies as members. This committee has to formulate policies for their area of jurisdiction keeping the State and National guidelines in vogue. Detailed guidelines, their powers, role and authorities of DDMA are covered under the provisos of the DM Act 2005.

Measures by the Central Government for Disaster Management[23]

3.10 **Measures by the Central Government.** In accordance with the provisions of the DM Act, the Central Government will take all such measures, as it deems necessary or expedient, for the purpose of DM and will coordinate actions of all agencies. The Central Ministries and Departments will take into consideration the recommendations of the State Government Departments while deciding upon the

[23] *Ref Sec 35 of DM Act 2005 and National Policy on DM 2009*

various pre-disaster requirements and for deciding upon the measures for prevention and mitigation of disaster. It will ensure that the Central Ministries and Departments integrate measures for the prevention and mitigation of disasters into their developmental plans and projects, make appropriate allocation of funds for pre-disaster requirements and take necessary measures for preparedness and to effectively respond to any disaster situation or disaster. It will have the power to issue directions to NEC, State Governments/SDMAs, SECs or any of their officers or employees, to facilitate or assist in DM, and these bodies and officials shall be bound to comply with such directions. The Central Government will extend cooperation and assistance to the State Governments as required by them or otherwise deemed appropriate by it. It will take measures for the deployment of the Armed Forces for disaster management. The Central Government will also facilitate coordination with the UN Agencies, International Organisations and Governments of Foreign Countries in the field of disaster management. The Ministry of External Affairs (MEA) in coordination with the Ministry of Home Affairs (MHA) will facilitate external coordination/cooperation. The relevant provisions of the DM Act 2005 are appended below:-

(i) **Sec 35 *(1) :*** Subject to the provisions of this Act (DM Act), the Central Government shall take all such measures as it deems necessary or expedient for the purpose of disaster management.

(ii) **Sec 35 (2) *:*** In particular and without prejudice to the generality of the provisions of sub-section (*1*), the measures which the Central Government may take under that sub-section include measures with respect to all or any of the following matters, namely:-

(a) Coordination of actions of the Ministries or Departments of the Government of India, State Governments, National Authority, State Authorities, governmental and non-governmental organisations in relation to disaster management;

(b) Ensure the integration of measures for prevention of disasters and mitigation by Ministries or Departments of the Government of India into their development plans and projects;

(c) Ensure appropriate allocation of funds for prevention of disaster, mitigation, capacity-building and preparedness by the Ministries or Departments of the Government of India;

(d) Ensure that the Ministries or Departments of the Government of India take necessary measures for preparedness to promptly and effectively respond to any threatening disaster situation or disaster;

(e) Cooperation and assistance to State Governments, as requested by them or otherwise deemed appropriate by it;

(f) Deployment of naval, military and Air Forces, other Armed Forces of the Union or any other civilian personnel as may be required for the purposes of this Act;

(g) Coordination with the United Nations agencies, international organisations and governments of foreign countries for the purposes of this Act;

(h) Establish institutions for research, training, and developmental programmes in the field of disaster management;

(i) Such other matters as it deems necessary or expedient for the purpose of

securing effective implementation of the provisions of this Act.

(iii) **Sec 35 (2) :** The Central Government may extend such support to other countries affected by major disaster as it may deem appropriate.

3.11 **Disaster Management Plans of Ministries or Departments of Government of India**[24]**.** As per Sec 37(*1*) of the DM Act, every Ministry or Department of the Government of India shall-

(i) Prepare a disaster management plan specifying the following particulars, namely:-

(a) The measures to be taken by it for prevention and mitigation of disasters in accordance with the National Plan;

(b) The specifications regarding integration of mitigation measures in its development plans in accordance with the guidelines of the National Authority and the National Executive Committee;

(c) Its roles and responsibilities in relation to preparedness and capacity-building to deal with any threatening disaster situation or disaster;

(d) Its roles and responsibilities in regard to promptly and effectively responding to any threatening disaster situation or disaster;

(e) The present status of its preparedness to perform the roles and responsibilities specified in sub-clauses (*iii*) and (*iv*);

(f) The measures required to be taken in order to enable it to perform its responsibilities specified in sub-clauses (*iii*) and (*iv*);

(ii) Review and update annually the plan referred to in clause (*a*);

(iii) Forward a copy of the plan referred to in clause (*a*) or clause (*b*), as the case

[24] *Ref Sec 37 of DM Act 2005.*

may be, to the Central Government which Government shall forward a copy thereof to the National Authority for its approval.

(iv) As per Sec 37(*1*) : Every Ministry or Department of the Government of India shall—

(a) Make, while preparing disaster management plan under clause (*a*) of sub-section (*1*), provisions for financing the activities specified therein;

(b) Furnish a status report regarding the implementation of the plan referred to in clause (*a*) of sub-section (*1*) to the National Authority, as and when required by it.

Measures by the State Government for Disaster Management[25]

3.12 **Measures by the State Government.** As per Sec 38(*1*), Subject to the provisions of this Act, each State Government shall take all measures specified in the guidelines laid down by the National Authority and such further measures as it deems necessary or expedient, for the purpose of disaster management. As per Sec 38(*2*), the measures which the State Government may take under sub-section (*1*) include measures with respect to all or any of the following matters, namely:-

(i) Coordination of actions of different departments of the Government of the State, the State Authority, District Authorities, local authority and other non-governmental organisations;

(ii) Cooperation and assistance in the disaster management to the National Authority and National Executive Committee, the State Authority and the State Executive Committee, and the District Authorities;

[25] *Ref Sec 38 of DM Act 2005*

(iii) Cooperation with, and assistance to, the Ministries or Departments of the Government of India in disaster management, as requested by them or otherwise deemed appropriate by it;

(iv) Allocation of funds for measures for prevention of disaster, mitigation, capacity-building and preparedness by the departments of the Government of the State in accordance with the provisions of the State Plan and the District Plans;

(v) Ensure that the integration of measures for prevention of disaster or mitigation by the departments of the Government of the State in their development plans and projects;

(vi) Integrate in the State development plan, measures to reduce or mitigate the vulnerability of different parts of the State to different disasters;

(vii) Ensure the preparation of disaster management plans by different departments of the State in accordance with the guidelines laid down by the National Authority and the State Authority;

(viii) Establishment of adequate warning systems up to the level of vulnerable communities;

(ix) Ensure that different departments of the Government of the State and the District Authorities take appropriate preparedness measures;

(x) Ensure that in a threatening disaster situation or disaster, the resources of different departments of the Government of the State are made available to the National Executive Committee or the State Executive Committee or the District Authorities, as the case may be, for the purposes of effective response, rescue and relief in any threatening disaster situation or disaster;

(xi) Provide rehabilitation and reconstruction assistance to the victims of any disaster; and such other matters as it deems necessary or expedient for the purpose of securing effective implementation of provisions of this Act.

Power of Requisition of Resources, Provisions, Vehicles, etc., for Rescue Operations, Relief and Rehabilitation etc during all the Stages of Disaster Management[26]**:**

3.13 **Sec 65(*1*) Refers:** If it appears to the National Executive Committee, State Executive Committee or District Authority or any officer as may be authorised by it in this behalf that—

(i) Any resources with any authority or person are needed for the purpose of prompt response;

(ii) Any premises are needed or likely to be needed for the purpose of rescue operations; or

(iii) Any vehicle is needed or is likely to be needed for the purposes of transport of' resources from disaster affected areas or transport of resources to the affected area or transport in connection with rescue, rehabilitation or reconstruction, such authority may, by order in writing, requisition such resources or premises or such vehicle, as the case may be, and may make such further orders as may appear to it to be necessary or expedient in connection with the requisitioning.

3.14 **Sec 65 (*2*) Refers :** Whenever any resource, premises or vehicle is requisitioned under sub-section (*1*), the period of such requisition shall not extend beyond the period for which such resource, premises or vehicle is required for any of the purposes mentioned in that sub-section.

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26 *Ref Sec 65 of DM Act 2005*

3.15 **Sec 65 (*3*) Refers :** In this section:-

(i) "Resources" includes men and material resources;

(ii) "Services" includes facilities;

(iii) "Premises" means any land, building or part of a building and includes a hut, shed or other structure or any part thereof;

(iv) "Vehicle" means any vehicle used or capable of being used for the purpose of transport, whether propelled by mechanical power or otherwise.

3.16 **National Crisis Management Committee (NCMC).** The NCMC, comprising high level officials of the GoI headed by the Cabinet Secretary, will continue to deal with major crises which have serious or National ramifications. It will be supported by the Crisis Management Groups of the Central nodal Ministries and assisted by NEC as may be necessary. The Secretary, NDMA will be a member of this Committee[27].

3.17 **National Policy on Disaster Management 2009.** Disaster management is an activity involving a number of Departments/agencies extending across all sectors of development in the event of a disaster. When a number of Departments/agencies are involved, it is desirable to have a policy in place, as it serves as an agenda for actions by all the relevant ministries, departments and agencies. The ***National Policy on Disaster Management*** came into being in 2009 to address these issues to build a safe and disaster robust India by developing a holistic, multiple disaster oriented and technology driven approach through a series of **Prevention, Mitigation, Preparedness and Response**. The primary objective of this policy is to:-

(i) Promoting a culture of Prevention, preparedness and resilience at all levels,

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[27] *Ref Para 3.3.5 of National Policy on Disaster Management 2009 published by NDMA, GoI, N. Delhi.*

through knowledge, education and innovation.

(ii) Encouraging Mitigation through technology and environmental sustainability.

(iii) Establish the technological and institutional frameworks.

(iv) Develop Scientific Forecasting and early warning systems

(v) Ensure efficient mechanism for identification, assessment and monitoring disasters.

(vi) Ensure prompt Response, relief rehabilitation mechanisms.

Disaster Management Planning [28] / [29]

3.18 The Disaster Management plan for the country has four essential components. These are:-

(i) Application of scientific inputs to forecasting and relief programs.

(ii) Timeless and dynamism of management of relief delivery.

(iii) People's participation in relief delivery and monitoring.

(iv) Contribution to resilience of societies and areas for improvement in quality of life.

3.19 Despite the recognition of the need to build up capabilities of the society to meet the challenges of disasters, the thrust of relief effort has, for a variety of reasons, concentrated on the alleviation and restoration aspects. On the occurrence of disasters, the need for continued vigil, preparedness and conscious effort to reduce the occurrence and impact of disasters has often been neglected. In a country, which boasts of planned developmental effort, perspective action still remains idealistic.

3.20 **Type of Responses.** The Central response can be: -

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[28] *ASCI Journal of Management Volume 24, 1995, Natural Disaster Management: Current Concerns by B Narasimhan, Ministry of Agriculture, GOI, New Delhi*

[29] *http://www.disastermgmt.bih.nic.in/*

(i) Policy response.

(ii) Administrative response.

3.21 **Policy Response.** The NDMA under Prime Minister would be responsible for providing the policy response to natural calamity. The objectives of policy response would be: -

(i) To empathize with the sufferings of the people affected by natural calamity.

(ii) To sub-serve long term and short term policy objectives of the Government.

3.22 **Administrative Response.** The response of the Administration to a situation arising out of a natural calamity are often on account of:-

(i) A follow-up of policy objectives of the Government.

(ii) The need for an assessment of the situation and for a central response.

(iii) States requests for Central assistance.

(iv) The need for information as a governance objective.

Primary Relief Functions

3.23 The primary relief functions of the Central Government would relate to: -

(i) Forecasting and operation of warning systems.

(ii) Maintenance of uninterrupted communication.

(iii) Wide publicity to warnings of impending calamity, disaster preparedness and relief measures through TV, AIR/FM channels and Newspapers.

(iv) Transport with particular reference to evacuation and movement of essential commodities and petroleum products.

(v) Ensuring availability of essential commodities at reasonable prices particularly the commodities through the Public Distribution System.

(vi) Ensuring availability of medicines, vaccine and drugs

(vii) Preservation and restoration of physical communication links.

(viii) Investments in infrastructure.

(ix) Mobilisation of Financial/Human and other infrastructural resources.

Secondary Relief Functions

3.24 **The Secondary Functions of the Central Government, which Supplement the States Relief Efforts, Would relate to:-**

(i) Flood/inflow forecasts from the Central Water Commission.

(ii) Relief, rehabilitation and restoration through military aid to authorities.

(iii) Contingency plan for crop and cattle preservation, nutrition and health measures.

(iv) Technical and technological inputs for provision of drinking water.

(v) Technical assistance in the water budgeting and water management.

(vi) Coordination of the activities of the State agencies and voluntary agencies.

Financial Aspects

3.25 **Procedure for Extending Financial Assistance to States.** Integration of disaster risk concerns into government budgets should be tackled from two angles, ensuring that levels of public expenditure on risk reduction are sufficient and that there are adequate financial arrangements to manage the residual risk. The presence of residual risk implies a continuing need to develop and support effective capacities for emergency services, preparedness, response and recovery, together with socioeconomic policies such as safety nets and risk transfer mechanisms, as part of a holistic approach. While there are certain budgetary allocations to partially address

requirements of relief (e.g., National Disaster Response Fund, State Disaster Response Fund), the mainstreaming of DRR requires each ministry, department and state/UT to make adequate provision for DRR as an integral part of the main budget by ensuring that all the major activities have incorporated DRR[30]. The Central Government by enacting DM Act 2005 has constituted National Disaster Relief Fund (NDRF) for meeting any disaster or threatening disaster situation. The NDRF shall be made available to the National Executive Committee to be applied towards meeting the expenses for emergency response, relief and rehabilitation in accordance with the guidelines laid down by the Central Government in consultation with the National Authority. Similarly, the central Government also created National Disaster Mitigation Fund for projects exclusively for the purpose of mitigation. The State Governments too are statutorily mandated to allocate various types of funds for meeting any disaster related contingencies. Every Ministry or Department of the Government of India too shall make provisions, in its annual budget, for funds for the purposes of carrying out the activities and programmes set out in its disaster management plan. There are also provisions for **Emergency procurement and accounting** of relief and rehab material, where by reason of any threatening disaster situation or disaster looming, the National Authority or the State Authority or the District Authority is satisfied that immediate procurement of provisions or materials or the immediate application of resources are necessary for rescue or relief, may authorise the concerned department or authority to make the emergency procurement and in such case, the standard procedure requiring inviting of tenders shall be deemed to be waived

[30] *National Disaster Management Plan, 2019. A publication of the National Disaster Management Authority, Government of India. November 2019, New Delhi. PP 127/128*

off [31]. These entire provisos are made under the DM Act 2005, thereby legally binding upon various stakeholders to allocate sufficient funds to mitigate the disasters in future.

3.26 The present scheme of financing the relief expenditure arising out of the natural calamities has come into force with effect from 01 April 1990, consequent upon the acceptance of the recommendations of the then National Finance Commission. Under this scheme, a Calamity Relief Fund (CRF) was formed in 2000-2001 and was constituted for each State. 75% of this amount shall be contributed by the Central Government in four quarterly installments and the balance 25% is to be provided by the State Governments from its own resources. It is the responsibility of the State Government to meet all expenditure arising out of the natural calamities. Similar to this, a National Centre for Calamity Management was formed under MHA with the task to monitor the occurrences of Disasters in the states. With the enactment of the Disaster Management Act in 2005 and consequent changes in the design and structure DM, the FC-XIII (submitted report in 2009) recommended the merger and transfer of NCCF balances, as on 31 March 2010, to the National Disaster Relief Fund which was accepted and notified by the Union Government. On the same lines, the CRF has been renamed as State Disaster Response Fund (SDRF) by 13th Finance Commission.

On 1 April 2010, based on the recommendations of the Finance Commission-XIII, the available balances in the CRF were merged with the SDRF. Later, the SDRF was reconstituted on the basis of 14th Finance Commission's (submitted the report in Feb 2015) recommendations in July 2015. The revised norms for assistance from SDRF were issued on 8 April 2015. For 2018-19, the budget estimates for the NDRF is Rs

[31] *Ref Sec 50 of the DM Act 2005*

864 crore. This is 9% higher than the revised estimates of Rs. 793 crore, for 2017-18. During 2018-19, the central government had released Rs. 9,658 crore, much higher than the budgetary allocation, to all States and during 2019-20. Till date, it has released Rs 6,104 crore to 24 states from the SDRF, the statement from the said Government agency. Natural disasters such as droughts, floods, cyclones, storms, landslides and earthquakes can lead to extreme distress and hardship among many small farmers who lead a subsistence existence. In these situations, they need at least a minimal amount of relief at a rapid pace. The Pradhan Mantri Fasal Bima Yojana, for which Rs. 9,000 Crore have been allotted in the 2017-18 Union Budget, is an important positive step towards risk mitigation for farmers during emergency situations[32]. Budget allocation in the last three financial years is appended below:-

Annual Budget Report-2018-19[33]

Finance and Budget:
Budget Estimate, Revised Estimate & Expenditure under ODMP, NCRMP and Est. Charges for the period April 2018 and March 2019 are as follows:

Name of the project	B.E 18-19	R.E 18-19	Expenditure up to 31.03.2019
National Cyclone Risk Mitigation Project (NCRMP) with World Bank Assistance	6039400	3030300	3026819
Other Disaster Management Projects – (ODMP)	355900	310800	264901
Est. Charges	321300	309000	286871*

Note: Inclusive of figures of I & B Ministry – DAVP (All figures in thousands**)**

[32] *Ref India three years Agenda, published by NITI Aayog GoI, New Delhi*

[33] *Annual Report 2018-2019 Published by NATIONAL DISASTER MANAGEMENT AUTHORITY (NDMA) Government of India NDMA Bhawan, A1, Safdarjung Enclave New Delhi – 110 029*

Table 3.1

Annual Budget Report-2017-2018[34]

Finance and Budget: **NDMA-Budget Allocation & Expenditure for the period April, 2017 to March, 2018**			
Name of the Project	**B.E 17-18**	**R.E 17-18**	**Expenditure up to 31.03.2018**
National Cyclone Risk Mitigation Project (NCRMP) with World Bank Assistance	6942500	6303900	6303233
Other Disaster Management Projects – (ODMP)	3449900	195600	155982
Est. Charges	282300	277700	268835

Note: Inclusive of figures of I & B Ministry – DAVP (All figures in thousands**)**

Table 3.2

Annual Budget Report-2016-2017[35]

Name of the project	**B.E 16-17**	**R.E 16-17**	**Expenditure up to 31.03.2017**
National Cyclone Risk Mitigation Project (NCRMP) with World Bank Assistance	6419200	6343300	5298398
Other Disaster Management Projects – (ODMP)	359700	177000	101905

Table 3.3

(NDMA- Budget Allocation & Expenditure (Non-Plan) for the period April 2016 to Jan 2017)

Non-Plan MH	B E 2016-17	R.E 2016-17	Exp. Up to

[34] *Annual Report 2018-2019 Published by NATIONAL DISASTER MANAGEMENT AUTHORITY (NDMA) Government of India NDMA Bhawan, A1, Safdarjung Enclave New Delhi – 110 029*

[35] *Annual Report 2016-2017 Published by NATIONAL DISASTER MANAGEMENT AUTHORITY (NDMA) Government of India NDMA Bhawan, A1, Safdarjung Enclave New Delhi – 110 029*

2245			31.01.2017
Total:	**309100**	**239900**	**186634**

Note: Inclusive of figures of I & B Ministry – DAVP (All figures in thousands**)**

Table 3.4

3.27 **Techno-Financial Regime**[36]**.** Para **4.5.1** of National Policy on Disaster Management 2009 envisages that considering that the assistance provided by the Government for rescue, relief, rehabilitation and reconstruction needs cannot compensate for massive losses on account of disasters, new financial tools such as catastrophe risk financing, risk insurance, catastrophe bonds, micro-finance and insurance etc., will be promoted with innovative fiscal incentives to cover such losses of individuals, communities and the corporate sector. In this regard, the Environmental Relief Fund under the Public Liability Insurance Act, 1991, enacted for providing relief to chemical accident victims is worth mentioning. Some financial practices such as disaster risk insurance, micro-finance and micro-insurance, warranty on newly constructed houses and structures and linking safe construction with home loans will be considered for adoption.

Warning Systems

3.28 The crucial warning systems are: -

(i) **Indian Meteorological Department (IMD) Under Min of Earth Sciences.** The nodal agency to issue warnings and forecast for drought, snow/dust storms, rainfall, floods, avalanches, earthquakes, cyclone, crop position etc.

(ii) **Tsunami Warning Centers, Under Min of Earth Sciences.** Established by GoI to monitor, forecast and warn the impending of Tsunamis.

[36] *Ref Para 4.5.1 of National Policy on Disaster Management 2009*

(iii) **The Department of Space under PMO.** Satellite monitoring of droughts, rivers, Cyclones and floods through the Remote Sensing/Satellites.

(iv) **Ministry of Water Resources.** Responsible for the Operation of the central network for flood forecasting and warning on inter-state rivers, provision of central assistance for some State Schemes in special cases and preparation of flood control master plans for rivers Ganga and Brahmaputra and provide technical guidance, scrutiny, clearance and monitoring of the irrigation, flood control and mitigation programs.

Indian Meteorological Department

3.29 IMD's practice of monitoring weather and climate spans more than 135 years giving it a sound and useful data base to fall back upon for environmental assessment. IMD monitors the rainfall situation through a wide network of 4000 Rain Gauge Stations, spread across the country. It also works in close coordination with the World Met Organisation. Before the onset of the monsoon in Peninsula, IMD issues long range forecast to facilitate agro-economic planning. Thereafter, as a part of short range forecast, a weekly rainfall analysis is made available to more than 50 meteorological sub-divisions, which cover over 150 agro-climatic regions. Rainfall data monitoring also helps in early warning about drought. Besides this, there are also 25 types of atmospheric monitoring networks that are operated and coordinated by the IMD. This includes meteorological, climatologically, environment, air pollution and other specialized observation of atmospheric trace constituents. It maintains 559 surface meteorological observatories, about 35 radio-stations and 64 pilot balloon stations for monitoring the upper atmosphere. Specialized observations are made for agro meteorological purposes at 219 stations and radiation parameters are monitored at

45 stations. There are about 70 observatories that monitor current weather conditions for aviation. The IMD collects meteorological data over oceans by an establishment of cooperation fleet of Voluntary Observing Ships (VOF) comprising merchant ships of Indian registry, some foreign merchant vessels and a few ships of the Indian Navy. These ships, while sailing on the high seas, function as floating observatories. Records of observations are passed on to the IMD for analysis and archival[37].

3.30 **Cyclone Warning.** The IMD has an observation network to detect cyclones through various cyclone detection radars on the coasts. The range of these radars is 400 km; simultaneously, the satellites like INSAT-1A, B & D Satellites, Megha, Tropiques & Kalpana I satellites monitors' cyclonic movements in India. Additionally, Ships and commercial & Defence radar systems are also used for cyclone warnings. About 260 ships of the Indian merchant fleet and more than 150 Naval and Coast Guard ships have meteorological observation systems on board.

3.31 **Flood Forecast.** The Central Water Commission in the Ministry of water resources has a flood forecast system with 157 flood forecasting centers covering 62 interstate river basins. In collaboration with IMD, they monitor rainfall and water levels in reservoirs.

3.32 **Seismic Observatories.** IMD is the nodal agency of GoI for monitoring **seismic** activity in and around the country. There are 84 such observatories to monitor seismic disturbances in India. Specifically, these observatories are established to monitor earthquakes; provide Hazard and risk assessment and carryout geophysical observations. National Geophysical Research Institute in Hyderabad is the Nodal institution involved with research and consultancy.

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[37] *Source DM in India, Prepared and published by MHA , GoI, May 2011*

Tsunami Warning System

3.33 **Tsunami Warning Centers[38].** The Indian Ocean Tsunami (December 26, 2004) has been one of the strongest in the world and the deadliest of all time by an order of magnitude. Driven by this national calamity, the Government of India decided to put in place an Early Warning System for mitigation of such oceanogenic disasters. Indian **National Center for Ocean Information Services** (INCOIS), Hyderabad was given the responsibility to coordinate the entire project and make it operational. The Indian Tsunami Early Warning System comprises a real-time network of seismic stations, Bottom Pressure Recorders (BPR), tide gauges and 24 X 7 operational tsunami warning Centre to detect tsunamigenic earthquakes and to monitor tsunamis and to provide timely advisories to vulnerable community by means of latest communication methods with back-end support of scenario database, vulnerability modeling and Decision Support System.

3.34 **Components of the Indian Tsunami Warning System.** The Early Warning System has the following components

(i) A dedicated Tsunami Warning Centre operating on a 24x7 basis for generation of timely advisories,
(ii) A network of land-based seismic stations for earthquake detection and estimation of focal parameters within the two known Tsunami genic zones and to communicate the same to the Early Warning Centre in near-real time
(iii) A network of 12 bottom pressure recorders (that could detect and measure a change in water level of 1 cm at water depths of up to six km of water) to detect and monitor tsunami around these two Tsunami genic zones
(iv) Real-time observational network for upper ocean parameters and surface met-ocean parameters, especially within the areas of cyclogenesis and coastal sea, for improving forecast of Storm Surges

[38] *Source: www. http://tsunami.incois.gov.in/*

(v) A network of fifty real time tide gauges, radar-based coastal monitoring stations and current meter moorings to observer progress of tsunami and storm surges

(vi) Generation of high resolution data base on bathymetry, coastal topography, coastal land use (for coastal areas within 1-3 km in general and for 10-25 km at selected areas near coastal water bodies)

(vii) Coastal vulnerability modeling & Inundation mapping

(viii) Capacity building, training and education of all stake holders on utilisation of the maps, warning and watch advisories.

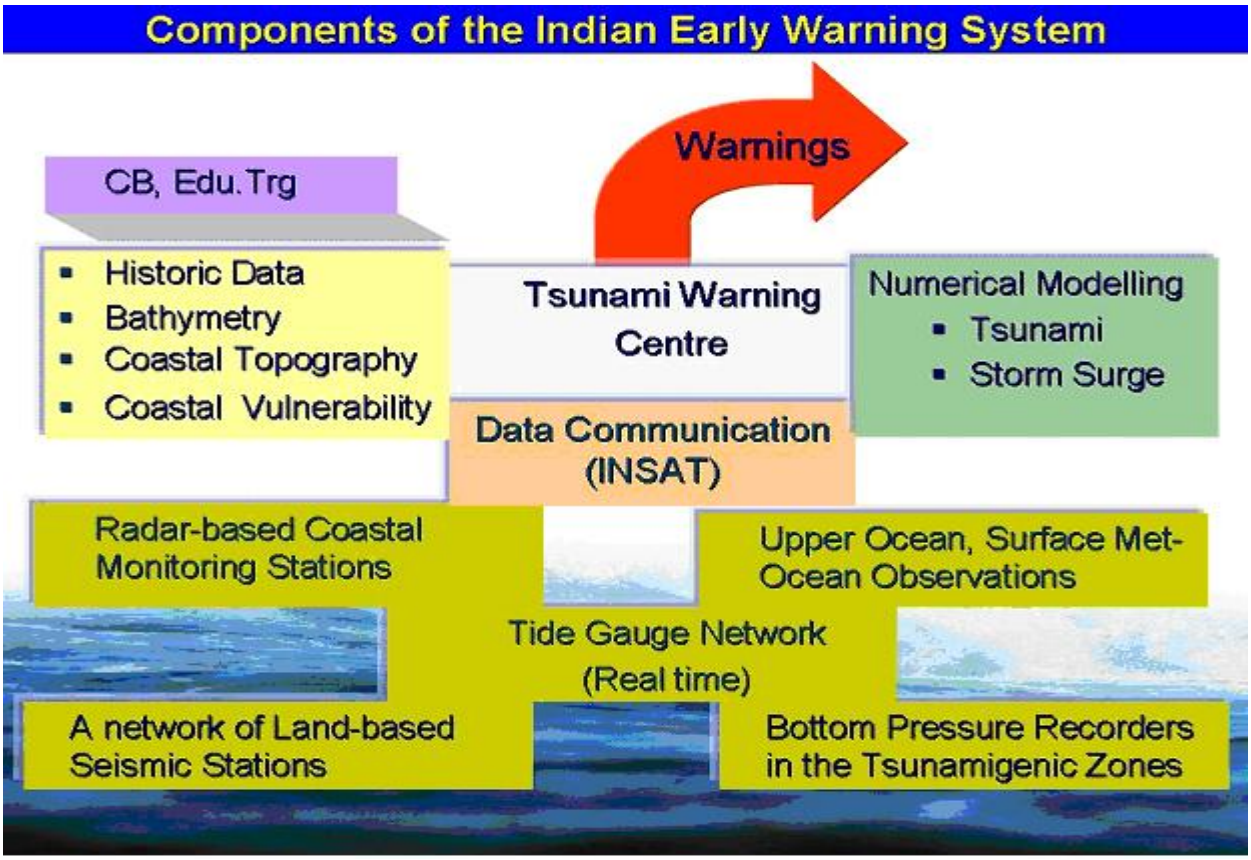

Fig 3.1

Source: http://tsunami.incois.gov.in/

3.35 **Tsunami Early Warning Centre for 24X7 Ops[39].** A state-of-the-art early warning centre is established with all the required computational and communication infrastructure that enables reception of real-time data from all the sensors, analysis of the data, generation and dissemination of tsunami advisories following a typical SOP. Seismic and sea-level data are continuously monitored within the Early Warning Centre employing a custom-built software application that would generate alarms/alerts in the warning centre whenever a pre-set threshold is crossed. Tsunami warnings/watches are then generated based on pre-set decision support rules and disseminated to the concerned authorities for action. The efficiency of the end-to-end system was proved during the massive under-sea earthquake of 8.4 M that occurred on September 12, 2007 in the Indian Ocean. It has taken two-and-half years to establish the Indian tsunami early warning system that was inaugurated on 15 October 2007.

3.36 The Early Warning Centre receives real-time Seismic data from the national seismic network of the IMD and other International seismic networks. The system detects all earthquake events of more than 6 Magnitude occurring within the Indian Ocean in less than twelve minutes of occurrence. Bottom Pressure Recorders (BPRs) installed in the Deep Ocean are the key sensors to verify the triggering of a Tsunami. The National Institute of Ocean Technology (NIOT) has installed 4 BPRs in the Bay of Bengal and the 2 BPRs in Arabian Sea. Additionally, Survey of India and NIOT have installed 30 Tide Gauges to monitor the progress of tsunami waves. Integrated Coastal and Marine Area Management (ICMAM) has customized and ran the Tsunami Model for five historical earthquakes and the predicted inundation areas. The inundated areas

[39] *Source: www. http:// tsunami. incois. gov.in/*

are being overlaid on cadastral level maps of 1:5000 scale. These community-level inundation maps are extremely useful for assessing the population and infrastructure at risk. High-resolution Coastal Topography data required for modeling is generated by the National Remote Sensing Centre (NRSC) using Airborne Laser Terrain Mapper (ALTM) and India's remote sensing satellite Cartosat1 Data. INCOIS has also generated a large database of model scenarios for different earthquakes that are being used for operational tsunami early warning.

3.37 Communication of real-time data from seismic stations, tide gauges and BPRs to the early warning center is very critical for generating timely tsunami warnings. A host of communication methods are employed for timely reception of data from the sensors as well as for dissemination of alerts. Indian Space Research Organisation has made an end-to-end communication plan using INSAT satellite. A high level of redundancy is being built into the communication system to avoid single point failures.

3.38 The National Early Warning Centre will generate and disseminate timely advisories to the Control Room of the Ministry of Home Affairs for further dissemination to the Public. For the dissemination of alerts to MHA a satellite-based virtual private network for disaster management support (VPN DMS) has been established. This network enables early warning center to disseminate warnings to the MHA, as well as to the State Emergency Operations Centers. In addition, Messages will also be sent by Phone, Fax, SMS and e-mails to authorised officials. In case of confirmed warnings, the National Early Warning Centre is being equipped with necessary facilities to disseminate the advisories directly to the administrators, Defence and Coastguard Stations along the

coast, media and public through SMS, e-mail, Fax, etc. The cyclone warning network of IMD and electronic ocean information boards of INCOIS could be effectively used for dissemination of warnings directly to the public as shown in fig 3.2.

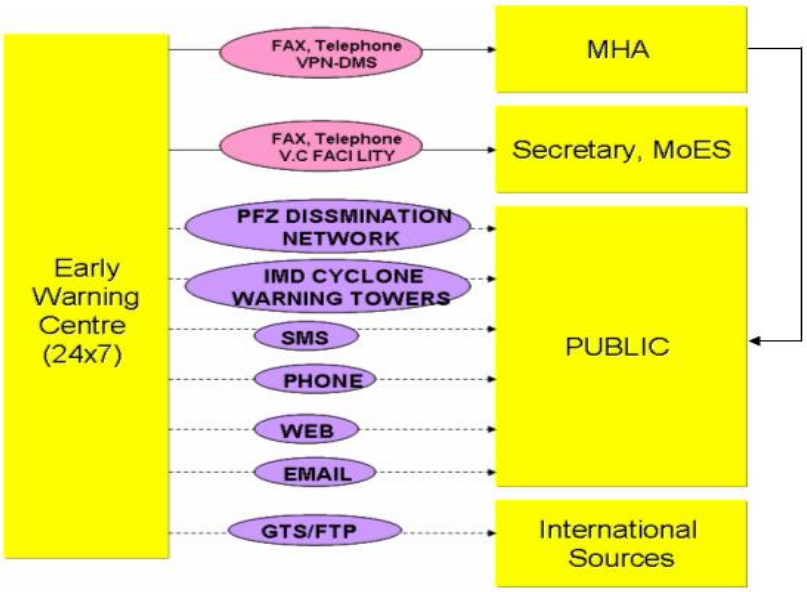

Fig 3.2

Source: www. http://tsunami.incois.gov.in/

3.39 World over many such centers have been established to provide early warning. Pacific Tsunami warning Centers, National Tsunami Warning Centers, North West Pacific Tsunami Advisory Authority are some of the major centers operated by the USA. Similarly, Indonesia, India, Japan are some of the other countries that monitors Tsunamis and issue timely warning to the possible affecting countries.

Remote Sensing [40]

[40] *Source: Remote sensing applications in disaster management By B. MANIKIAM, Disaster Management Support, ISRO HQ, Antariksh Bhavan, New B.E.L. Road, Bangalore Jan 2003*

3.40 Space based systems with synoptic and repetitive coverage; have clearly demonstrated their capability in providing vital information and services in a disaster situation. Earth observation satellites provide comprehensive, synoptic and multi temporal coverage of large areas in real time and at frequent intervals and thus have become valuable monitoring tools. The most important applications of satellites are in detecting, providing and delivering early warnings through earth observations, data relay, navigation, and communication capabilities. Satellites are particularly suited to deliver locale-specific disaster warning and communications to remote, rural and under-developed areas. Remote sensing in particular serves three main functions:

(i) Providing large-area reconnaissance to enhance situational awareness and map damage;

(ii) Assessing damage to properties critical for livelihoods and stability, such as homes and businesses; and

(iii) Determining impact on critical infrastructures including roads, energy grids, and water pipes.

3.41 **Current Capabilities of Space Systems.** Remote sensing activities in India was initiated using aerial photography in early 1970's and graduated to satellite remote sensing with the experimental remote sensing satellites – Bhaskara 1 and Bhaskara – 2 launched in 1979 and 1981 respectively. Experience was gained in analyzing images at 1 km resolution from the two band TV Cameras and passive microwave sensors in 19, 22 and 31 GHz bands. The first operational Indian Remote Sensing Satellite (IRS 1A) launched in 1988 carried LISS(Linear Imaging Self Scanning) cameras employing 2048 element Charge Coupled Devices (CCD) operating in the push-broom mode to provide imageries in four spectral bands with a resolution of 72.5 and 36.25 meters.

Improved resolution was achieved in IRS 1C / 1D satellites with LISS-III sensors designed to provide multi-spectral information at 23.5 m resolution, a middle infrared sensor with a resolution of 70.5 m and panchromatic imageries with 6.5 m resolution. The Wide Field Sensor (WiFS) with image band of 770 kms in resolution of 188 m is useful for rapid monitoring of natural resources. Recent developments are in developing microwave sensors for all weather sensing. The development of active microwave systems such as imaging radars, scatterometer and altimeter add a new dimension in earth observation capability with their ability to provide imagery with a resolution approaching that of optical remote sensing, under all weather conditions.

3.42 **Geophysical Satellites.** This class of satellites gives geophysical parameters related to ocean and atmosphere. It is now possible using satellite borne microwave altimeter to measure the sea height to within five to ten centimeters. Laser tracking from ground to satellites with retro-reflectors permit determination of baseline lengths to within about centimeters. The Indian satellites IRS P3 (with Modular-Optoelectronic Sensor – MOS) and IRS P4 with Microwave Scanning Radiometer - MSMR) gave observations on geophysical parameters related to atmosphere and ocean. Repeated observations of baselines in earthquake - prone regions can detect buildup of strain that may indicate an impending earthquake. The microwave payloads onboard ERS and RADARSAT are providing ocean parameters such as sea surface temperature, surface wind, sea ice etc.
US Navy's Global Positioning System (GPS) is being used to measure précising ground movements related to seismicity.

3.43 **Meteorological Satellites[41].** Geostationary meteorological satellites have a distinct advantage over low earth orbiting satellites because of their capability to image on a continuous basis over large areas, which is particularly important for tracking cyclones and measurement of wind vectors derived from the displacement of specific cloud features in successive imageries. Many of these satellites have also incorporated data collection platforms that can periodically interrogate meteorological information from unattended platforms located in inaccessible and remote areas and transmit them to a central location. The INSAT systems in operation over the past two decades are giving meteorological observations over Indian region through the Very High Resolution Radiometer operating in visible and thermal channels. The observations include cloud cover, Cloud Motion Vectors (at 3 levels), Sea Surface Temperature, and Outgoing Long Wave Radiation. Several polar-orbiting meteorological satellites are in operation such as NOAA series and DMSP. The capabilities of the Indian satellites have reached such a state that now they can compete and match with any of the advanced countries capabilities.

3.44 **Potential Applications of Remote Sensing Data.** In many ways, remote sensing is ideally suited for disaster management. First of all it provides a database from which the evidences left behind by disasters that have occurred before can be interpreted, and combined with other information to derive hazard maps. Satellite images provide a synoptic overview and deliver very useful geomorphologic information, for an extensive range of scales, from entire continents to details of a few meters. Secondly, many forms of disasters, such as floods, drought, cyclones, volcanic eruptions, etc. will

[41] *Authors - Ramana, Ramesh, Tiwari, Sudheer, Srikanth, PY - 2019/08/19 SP - 487 SN - ISBN: 978-93-87973-62-6 T1 - Geospatial Technologies for Impact Assessment of Extreme Weather Events on Agriculture (Page:487)*

have certain precursors. Satellites are often used to detect the early stages of these events as anomalies in a time series. Images are available at short time intervals, and may be used for the prediction of both rapid and progress of disasters. Then, when a disaster occurs, the speed of the data collection from satellites and the possibility of further dissemination of information with a matching swiftness make it possible to monitor the occurrence of the disaster. Many disasters will affect large areas and only remote sensing would provide a matching spatial coverage of large areas. Remote sensing also helps us to monitor the real-time monitoring of an occurrence while the forces of nature are in full swing. The impact and departure of the disaster leaves behind an area of immense devastation. Remote sensing can assist in real time assessment of the damage and aftermath monitoring as well, providing a quantitative base for relief operations. Finally, satellite data can be used to map the new situation and update the databases used for the reconstruction of an area and to prevent occurrence of such a disaster in future. Following sections give a brief summary of various applications of satellite data for effective management of disasters.

3.45 **Cyclone Monitoring and Warning[42].** Meteorological satellites are valuable for monitoring and forecasting of cyclones. INSAT/VHRR images are being used to identify cloud systems over the oceans, where no observational data is available, as well as for cyclone tracking, intensity assessment and prediction of storm surges, etc. They need to be supplemented by ground meteorological observations and radar data for accurate assessment of rainfall intensity. An innovative use of INSAT has been in the implementation of the unique, unattended, locale specific Cyclone Warning Dissemination System (CWDS) consisting of over 250 disaster warning

[42] *Indian Satellite Applications to Weather & Climate Studies Published on Jan 29, 2016*

receivers installed in cyclone prone areas of the country, designed to deliver timely warning to coastal villages about an impending cyclone. Since the commissioning of DWS and its first operational use for disaster warning in 1987, CWDS has become a vital disaster mitigation mechanism. Current research around the globe is concentrating on use of meso-scale models with satellite data inputs to enhance the cyclone intensity and track its forecast.

3.46 **Flood Management.** Despite limitations of cloud-cover or overcast conditions and long revisit period, satellites have been providing vital information towards:-

(i) Precipitation forecast and warning

(ii) Inundation mapping and damage assessment and

3.47 **Flood Plain Management.** Recent advances in using microwave data, especially to deal with persistent cloud cover over the affected areas have enhanced the potential use of remote sensing by virtue of its all-weather capability. Besides providing inputs for quantitative estimation of precipitation, geo-stationary satellites have become increasingly helpful for collection of data on rainfall, river stages, etc., for remote, uninhabited locations over the land using data Collection Platforms.

3.48 **Inundation Mapping and Damage Assessment.** Mapping of flood-affected areas is one among the foremost successful applications of satellite remote sensing in flood management. Because of the unique spectral signature, it is possible to map areas under standing water, areas from where flood water has receded, submerged standing crop areas, sand casting of agricultural lands, breaches within the embankments, volumes in catchment areas, marooned villages and towns, etc. Using multi-date satellite imageries, the extent of damage due to crop loss, destruction of infrastructure

facilities etc., can be assessed. Near real time monitoring and damage assessment of all major flood events are being undertaken operationally. Global Positioning System is being used to aid in the development of a Digital Elevation Model (DEM) for a flood prone area in Andhra Pradesh, to enable assessment of spatial inundation at different water levels in the river. When satellite derived land use/cover and ancillary ground based socio-economic data is draped over the DEM, flood vulnerability can be assessed to provide location specific flood warnings. Remote sensing data are evaluated for integration with existing forecasting models. Also microwave data from RADARSAT is used in conjunction with optical data to overcome the limitation of cloud cover.

3.49 **Earthquakes.** Earthquake risk assessment involves identification of seismic zones through collection of geological/structural, geophysical (seismological) and geomorphologic data and mapping of known seismic phenomena within the region (mainly epicenters with magnitudes). Satellite imagery could be used in delineating neo-tectonic structures and to clarify seismo-tectonic conditions in earthquake risk zones. Accurate mapping of geomorphologic features adjoining topographies reveal active movement or recent tectonic activity along faults. Studies carried out earlier have highlighted the correlation between major lineaments and the seismic activity in Latur area in Maharashtra, India. It was observed that between 1967 and 1977, about 100 earthquakes (86 in Koyna region alone) of intensity 4 or above on Mercalli scales have occurred in Southern Peninsula. Most of these have been found to occur in the vicinity of NNE-SSW to NW-SE trending mega lineaments. The geotectonic settings of the Gujarat earthquake of January 2001 were studied by National Remote Sensing Agency using IRS data.

3.50 **Landslides.** Satellite data and aerial photographs have been used to develop appropriate methodologies for terrain classification and preparing maps showing landslide hazard zonation. Using GIS techniques, the thematic layers on geology, soils, slope, land use/cover etc. are suitably integrated to arrive at relative classes of landslide hazard zonation. These imageries have helped in identifying 71 potential landslide areas in the country. The studies are to be supplemented by aerial photographs for high-resolution contour mapping with intervals of better than 2m. Recently the landslide zonation was carried out for 2000 kms stretch of pilgrimage route in upper Himalayas.

3.51 **Space-based Disaster Management Support.** With the vast experience gained through pilot scale studies and operational use of space data, the concept of a space based observation and communication system for disaster management is being evolved in the country. The most important need is to assess the overall requirements of users at various levels and the delivery mechanisms that could provide the services effectively towards monitoring, forecasting, warning, assessment, prediction and reduction of losses due to natural disasters. The information required by disaster managers in each of the critical phase of disaster management, which includes mitigation and preparedness, response and recovery/relief need to be met. The elements of such a system therefore will consist of:

(i) Database design

(ii) Near real time monitoring/mapping

(iii) Modeling framework

(iv) Networking solutions

3.52 **Multi-Agency Interface.** The future thrust areas are improved disaster forecasting through use of models, networked systems for on-line decision support and advanced

communication systems for warning and relief. The emerging requirements from the satellite systems are :

(i) Capability for imaging the whole country at frequent intervals (say, once in 4-6 hours) at resolutions of about 100-200 m (in 3-4 bands in visible, near infra-red and thermal);

(ii) Capability to observe the disaster affected areas (soon after occurrence) at high-resolutions (5-10 m, multispectral) under all-weather conditions towards damage assessment;

(iii) Capability to observe the localised areas of disasters (groups of settlements, habitation) at about < 1 m resolution for assessing infrastructure damage and for relief/rehabilitation work;

(iv) Capability to detect micro-movements of the crustal plates (using satellite GPS) for earthquake forewarning;

(v) Data Collection Platforms and Ocean Data Buoys to fill gaps in observation network.

3.53 Remote sensing provided positive preliminary results in estimating the impact of several types of disasters by means of specific applications like, the use of "structured light" laser scanning devices for generating 3D spatial models of damaged areas. Satellite imagery has enabled timely post-cyclone damage assessment of tropical forests and accurate damage assessment after a tsunami. Relatively high accuracy in the detection of damage after earthquakes was reported in Haiti and Japan in the past. Novel methods for automated processing are being developed by many scientific communities. Crowd sourced approaches can complement on ground and remote sensing data can succeed in a more fine grained and dynamic understanding of impacts nature’s fury. Due to the increased

availability of satellite imagery from government sources as well as private sources, also images from drones, crowd-based micro-tasking, etc. are often used to analyse, identify and assess the damages in a big way.

CHAPTER - IV

DISASTER PREVENTION, MITIGATION & PREPAREDNESS

4.1 The ***Yokohama***[43] message emanating from the international decade for natural disaster reduction in May, 1994 underlined the necessity for an emphatic shift within the strategy for disaster mitigation. The ***Yokohama*** Strategy also emphasized that disaster prevention, mitigation and preparedness are better than disaster response in achieving the goals and objectives of vulnerability reduction. The ***Hyogo Conference*** adopted the framework of action 2005-2015 called "Building the resilience of countries and Communities to Disaster". Similarly, Targets enshrined in the ***Sendai*** Framework for Disaster Risk Reduction (SFDRR) 2015-2030 the Plan has also focused on achieving a coherence with other international agreements such as Sustainable Development Goals (SDGs) and Paris Agreement on Climate Change (COP 21) (under the United Nations Framework Convention on Climate Change in December 2015) are closely linked with the Sustainable Development Goals. These are often achieved as long as the country mitigate losses – both in terms of lives and livelihoods, create resilient infrastructure, and equip adequately to affect with the imminent impacts of disasters and global climate change thereof.

4.2 Further, In order to strengthen the policy framework and also in conformity with the International Strategy for Disaster Reduction at the ***Rio Declaration***, the Millennium Development Goals and therefore the Hyogo Framework 2005-2015, the following themes that underpin this policy were promulgated by India[44] :-

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[43] Books.google.co.in › books, *Pratiyogita Darpan - Jan 2008 - Vol. 2, No. 19*

[44] *Armed Forces In Disaster Management: Challenges In Indian Perspective by Moirangmayum Sanjeev Singh, Research Fellow (ICSSR), Centre for Police Administration, UIEASS, Panjab University, Chandigarh published by SJIF 2014*

(i) Community-based disaster management, including last mile integration of the policy, plans and execution.

(ii) Capacity development in all related areas.

(iii) Consolidation of past initiatives and best practices.

(iv) Cooperation with agencies at the national, regional and international levels.

(v) Compliance and coordination to obtain a multi-sectorial synergy.

4.3 Deriving from the above themes, the Indian National Policy on Disaster Management 2009 has evolved with the following objectivities:-

(i) Promoting a culture of prevention and preparedness – by Centre-staging DM as an overriding priority at all levels and at all times.

(ii) Encouraging mitigation measures based on state-of-the-art technology and environmental sustainability.

(iii) Mainstreaming DM concerns into the development planning process.

(iv) Putting in situ a streamlined institutional techno-legal framework so as to create and preserve the integrity of an enabling regulatory environment and a compliance regime.

(v) Developing contemporary forecasting and early warning systems backed by responsive and fail-safe communications and Information Technology (IT) support.

(vi) Promoting a productive partnership with the Media, NGOs along with the Corporate Sector in the areas of awareness generation and capacity building.

(vii) Ensuring efficient response and relief with a caring humane approach towards the vulnerable sections of the society.

(viii) Making reconstruction an opportunity to rebuild back better and construct disaster-resilient structures and habitats

Govt of India Initiatives[45]

4.4 Mainstreaming Disaster Management into Development. The Govt of India has adopted mitigation and prevention as essential components of their development strategy. The Twelfth Five Year Plan (2012-2017) document features a detailed mention on Disaster Management. The plan emphasizes[46] the very basics, i.e., the development Emergency Response can't sustain without Mitigation, Prevention and Preparedness without effective handling of the disasters as they are being amalgamated into building developmental process and involvement of private sector participation and Government DM support machineries like ISRO, Geo Imaging Satellite (GISAT) and IMD.

4.5 Flood Preparedness and Response. In order to respond effectively to floods, Ministry of Home Affairs has initiated National Disaster Risk Management Programme encompassing all the flood-prone States. Assistance is being provided to the States to draw up disaster management plans at the State, District, Block/Taluka and Village levels. Awareness generation campaigns to sensitize the all the stakeholders on the necessity for flood preparedness and mitigation measures.

4.6 Earthquake Risk Mitigation. A comprehensive programme has been taken up for earthquake risk mitigation. Although, the BIS have laid down the standards for construction within the seismic zones, these aren't followed strictly by the realtors. The building construction in urban and suburban areas is regulated by the Town and Country Planning Acts and Building Regulations. In many cases, the Building

[45] *Environmental Studies - Jayshree A. Parikh, V.M. Balsaraf, P.B. Dwivedi – 2010 Page 95*
[46] *Disaster Management in India –a status Report GoI MHA, Pp 14*

regulation doesn't incorporate the BIS codes. Even where they incorporate the regulations, the shortage of data and lack of knowledge regarding seismically safe construction norms, amongst the architects and engineers as well as lack of awareness regarding their vulnerability among the population led to most of the construction within the urban/sub-urban areas are being without BIS confirmations.

4.7 National Core Group for Earthquake Risk Mitigation[47]. A National Core Group for Earthquake Risk Mitigation has been constituted consisting of experts in earthquake engineering and administrators. The Core Group has been assigned with the responsibility of drawing up a design and plan of action for mitigating the impact of earthquakes; providing advice and guidance to the States on various aspects of earthquake mitigation.

4.8 National Programme for Capacity Building of Engineers and Architects in Earthquake Risk Mitigation. Two National Programmes for Capacity Building in Earthquake Risk Mitigation for Engineers, planners and Architects respectively, are approved to support the State Governments in buildup capacities for earthquake mitigation. Under these two programmes 10,000 engineers and 10,000 architects in various States shall be given training in seismically safe building designs and related techno-legal requirements. Assistance is being provided to the State/UTs to build up the capacities of more than 125 State Engineering Colleges and 110 Architecture Colleges to be able to provide advisory services to the State Governments to put in place appropriate techno-legal framework, assessment of buildings / infrastructures and their retrofitting.

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[47] *Environmental Studies - Page 95 – auths Jayshree A, Parikh, V.M.Balsaraf, P.B. Dwivedi - 2010*

4.9 Earthquake Engineering in Undergraduate Engineering/Architecture Curricula. Elements of earthquake engineering are being integrated into the undergraduate engineering and architecture courses. Model course curricula are developed for adoption by various technical institutions and universities and circulated to the Universities and Technical Institutions for integration into the under graduate curriculum.

4.10 Training of Rural Masons. A programme to assist the States in training and certification of fifty thousand masons has been formulated in consultation with Housing and Urban Development Corporation and the Min of Rural Development. They will be imparted training on various construction aspects, keeping the vulnerabilities of the area concerned in mind. They will be trained on material usage, design aspects, disaster resilient models and possible Don'ts.

4.11 Training, Workshops and Counseling Sessions for Trauma Victims. NIDM is the apex body created under the provisions by an act of the Parliament for Training. This Institute has developed various modules to impart Training to Trainers (preferably non-medical personnel, including the officers of certain ministries and departments, down to the district level) on post disaster psychological & social support in consultation with the experts of the National Institute of Mental Health and Neuro Sciences Bangalore. This will facilitate the target group to gear up for any eventualities should there be a requirement to conduct counseling sessions to the distressed population. After any disaster, the emotions will flare up due to the losses of their near and dear ones. These emotions vary from persons to communities to gender, and undergo changes depending on the coping capacity and socio-economic conditions. Some of the factors that could influence the reactions among people are nature and magnitude of the disaster, the period

of exposure to the disaster, availability of sufficient social support. Therefore, it is incumbent on the administrators and counselor to be flexible and assessment should commensurate with the ongoing needs and manifestation of stress levels of the affected.

4.12 National Earthquake Risk Mitigation Project. An Earthquake Mitigation Project has been drawn up by GoI The programme includes detailed evaluation and retrofitting of lifeline buildings such as hospitals, schools, water and power supply units, telecommunication infrastructure, airports/airport control towers & terminals, railway stations, bus stands and important administrative buildings in the States/UTs in seismic zones IV and V.

4.13 Accelerated Urban Earthquake Vulnerability Reduction Programme. An accelerated urban earthquake vulnerability reduction programme has been launched in over 38 cities in seismic zones III, IV & V having a population of 5 lakh and above.

4.14 Mainstreaming of Mitigation in Rural Development Schemes. Rural housing and community assets for vulnerable sections of the population are created on a fairly large scale by the Ministry of Rural Development under the scheme Indira Awas Yojna (IAY) and Sampooran Grameen Rojgar Yojna (SGRY). About 2.50 lakh small but compact housing units are being constructed every year, along with community assets such as community centers, recreation centers, anganwadi centers etc.

4.15 Core Group on Cyclone Mitigation. A National Core Group on Cyclone Monitoring & Mitigation has been constituted by the GoI. Experts from Indian Meteorological Department, National Centre for Medium Range Weather Forecasting, Central Water Commission, National Remote Sensing Agency and Indian Space Research Organisation have been made the Members of the Core Group, besides administrators from the relevant Ministries/Departments and State Governments

susceptible to cyclones. The Group has been assigned the responsibility of looking at warning protocols for cyclones; coordination mechanism between different Central and State Ministries / Departments / Organisations; mechanism for dissemination of warning to the local people and; cyclone mitigation measures required to be taken for the coastal States.

4.16 National Cyclone Mitigation Project. A project for Cyclone Mitigation with an estimated cost of Rs.1050 crore has been earmarked in consultation with the cyclone vulnerable States. This project envisages construction of cyclone shelters, plantation along the coastal belt in areas which are prone to storm surges, strengthening of various warning systems, training and education to volunteers etc.

4.17 **Landslide Hazard Mitigation.** A National Core Group has been constituted under the Chairmanship of Secretary, Border Management and comprising of Secretaries of Department of Science and Technology, Road Transport & Highways, and the Heads of Geological Survey of India and National Remote Sensing Agency for drawing up a strategy and plan of action for mitigating the impact of landslides, provide advice and guidance to the State Governments on various aspects of landslide mitigation, monitor the activities relating to landslide mitigation including landslide hazard zoning and to evolve early warning systems and protocols for landslides/landslide risk reduction. The Government has designated Geological Survey of India[48] as the nodal agency responsible for coordinating / undertaking geological studies, landslides hazard zoning monitoring landslides/avalanches, studying the factors responsible and suggesting precautionary and preventing measures.

[48] *National Disaster Management Guidelines—Management of Landslides and Snow Avalanches, 2009. A publication of the National Disaster Management Authority, Government of India. June 2009, New Delhi.*

4.18 **<u>Human Resource Development</u>.** Human Resource Development at all levels is critical to institutionalization of disaster mitigation strategy. The National Centre for Disaster Management at the national level has been set up under the statutory provision of DM Act 2005 as the **National Institute of Disaster Management (NIDM), New Delhi** under the aegis of MHA. It is being developed as a Regional Centre of Excellence in Asia. The mission[49] of this institution is as follows:-

(i) To work as a think tank for the Government by providing assistance in policy formulation and;

(ii) To facilitate in reducing the impact of disasters through:

(a) Planning and promoting training and capacity building services including strategic learning.

(b) Research, documentation and development of national level information base.

(c) System development and expertise promotion for effective disaster preparedness and mitigation.

(d) Promoting awareness and enhancing knowledge and skills of all stakeholders.

(e) Strengthening institutional mechanisms for training and capacity building of all stakeholders.

(f) Networking and facilitating exchange of information, experience and expertise.

[49] *Source: www.nidm.gov.in*

(iii) To build a national hub to share and learn and to create a critical mass of institutions, trainers and trained professionals, the NIDM has evolved some strategic plans[50] as appended below:-

(a) To undertake quality research covering both natural and human induced disasters, with a multi-hazard approach

(b) To work as a National Resource Center for the central and state governments in the country through effective knowledge management and sharing of best practices

(c) To professionalize disaster risk reduction and emergency management in India and other neighboring countries by developing an independent cadre of professionally trained emergency and mitigation managers.

(d) To promote formal training and education for disaster management in India and in the region

(e) To build working partnerships with the Government, universities, NGOs, corporate bodies and other national and international Institutes of eminence.

(f) To link learning and action by building a synergy between institutions and professionals in the sector.

4.19 Further, the National Institute of Disaster Management mandate was to develop training modules at different levels, undertake training of trainers and organize training programmes and workshops for planners, administrators and line functionaries. The other functions assigned to the National Institute of Disaster Management include[51] :-

(i) Develop training modules, undertake research and documentation in disaster

[50] *Source: www.nidm.gov.in*
[51] Para 42(9) of DM Act 2005

management and organise training programmes;

(ii) Formulate and implement a comprehensive human resource development plan covering all aspects of disaster management;

(iii) Provide assistance in national level policy formulation;

(iv) 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;

(v) 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;

(vi) Develop educational materials for disaster management including academic and professional courses;

(vii) Promote awareness among stakeholders including college or school teachers and students, technical personnel and others associated with multi-hazard mitigation, preparedness and response measures;

(viii) Undertake, Organise and facilitate study courses, conferences, lectures, seminars within and outside the country to promote the aforesaid objects;

(ix) Undertake and provide for publication of journals, research papers and books and establish and maintain libraries in furtherance of the aforesaid objects;

(x) Do all such other lawful things as are conducive or incidental to the

attainment of the above objects; and

(xi) Undertake any other function as may be assigned to it by the Central Government.

4.20 **Disaster Preparedness.** Mitigation and preparedness measures go hand in hand for vulnerability reduction and rapid professional response to disasters. The Bhuj earthquake in January, 2001 brought out several inadequacies in the system. Professionally trained search and rescue teams were not available; specialized dog squads to look for live bodies under the debris were not available; and there was no centralized resource inventory for emergency response. Although the Army & the Indian Air Force played a pivotal role in search and rescue and also set up their own field hospitals after the collapse of Government hospital at Bhuj, the need for fully equipped mobile hospitals with trained personnel was felt acutely. Despite these constraints, the response was fairly well organized. However, had these constraints been taken care of beforehand, the response would have been even more professional and rapid which may have reduced the loss of lives. A Steering Committee has been constituted in the Ministry to oversee the creation of capabilities for emergency response and elaborate plans are now under execution to improve disaster preparedness & response.

4.21 **Specialist Response Teams.** The Central Government is now in the process of training and equipping many battalions of CPMFs as Specialist response teams. Each team would consists doctors, paramedics, structural engineers etc and thus there will be many groups of Specialist Search and Rescue Teams in the earmarked battalions. The process of training and equipping of these specialist search and rescue teams etc has taken off very well.

4.22 **Setting up of Search and Rescue Teams in States.** The States have been advised to set up their own Specialist Teams for responding to disasters. Ministry of Home Affairs will provide the technical advice and assistance for the training of State Trainers thru the Indian Armed Forces/CAPF units as well as organisations like NISA, NFSC & NIFSE Ngp, and NDRF etc. Many States/UTs have initiated action for setting up of their own specialized SAR units and have identified the Training Centers for training in Search and Rescue areas.

4.23 **Regional Response Centers.** Fourteen Regional Response Centers (RRCs) were set up across the country to enable immediate response to floods, cyclones, earthquakes, landslides etc. Standard cache of equipment and relief materials will be kept in these RRCs and Specialist Response Teams will be stationed during the flood/cyclone seasons for immediate assistance to the State Governments. States like Haryana actually placed lots of rehabilitation material at the disposal of many Air Force units so that they can be air lifted without any delay.

4.24 **Health Preparedness.** A 200 bedded mobile hospital, fully trained and equipped is being set up and attached to a leading Government hospital in Delhi. Three additional mobile hospitals with all medical and emergency equipment are proposed to be located in various parts of the country. These mobile hospitals will also be attached to the leading Government hospitals in the country and will be airlifted to the place of disaster immediately. All the Armed Forces have their own mobile emergency and mobile establishments with adequate men and material that are at standby to move at short notice. Most of these units also have the expertise to deal with CBRN contingencies too.

4.25 **Hospital Preparedness and Emergency Health Management in Medical Education.** Hospital preparedness is crucial to any disaster response system. Every hospital needs to have an emergency preparedness plan to deal with mass casualty incidents and the hospital administration/ doctor are trained for this emergency. At present, the medical council of India is in the process of revising the curriculum for medical doctors to include Hospital Preparedness for emergencies. Therefore capacity building through in-service training programs for the current heath managers, Doctors, hospital administrators and Para-medics in Hospital Preparedness for emergencies and/or mass causality incident management is crucial[52].

4.26 **Emergency Support Function Plans**. It is generally experienced that the departments concerned start constituting teams/mobilizing resources only after the crisis/disaster has struck, leading to inordinate delays. The relevant ministries/departments/agencies have been asked by the MHA to draw up Emergency Support Function (ESF) Plans and constitute response teams and designate resources well in advance so that timely response is initiated. States have also been asked to take similar steps in drawing ESF. Similarly States have been advised to have pre-contract / agreement for all disaster relief items so as to avoid delays in procuring relief items after disaster situations.

4.27 **Emergency Operation Centers (EOCs).** Both at central level as well as at State levels**,** the a 24X7 **EOCs** would be set at once to oversee the command and control of the Disaster relief, look after law and order issues as well as disaster management. Most of the States vulnerable to the disasters have procured Rehab Equipment under the disaster risk management programme, and are placed at the

[52] *Disaster Management in India: A Status Report 2004 & The Twelfth Five Year Plan (2012-2017) document*

disposal of these EOCs**.** Hazard zone-wise standard layout, structural design and construction drawings have been developed for State and District EOCs and shared with all the States by the MHA.

4.28 **National Disaster Communication Network (NDCN)[53].** Building disaster resilience in the society through creation of a state-of-the-art knowledge-based Digital Information and Communication Support Infrastructure called National Disaster Management Information and Communication System (NDMICS) has been formulated to provide GIS based value-added information along with assured multi-services of audio, video and data to the various stakeholders for proactive and holistic management of disasters. Value added information along with data would be sent to the right people at the right time by establishing a reliable, dedicated and latest technology based, National Disaster Communication Network, with particular emphasis on last-mile connectivity to the affected community during all phases of disaster continuum[54] (as shown in the figure). NDMICS under the aegis of NDMA provides detailed guidelines incorporating all the technical and operational issues for an assured multi-service of audio, video and data augmented along with GIS-based value-added information to the various stakeholders. This would also facilitate proactive and holistic management of disasters. Services of domain experts from IT, space based technologies and vulnerability analysis and risk assessment would be inducted to generate the proposed value added information, establishing a reliable, dedicated and technology-based, National Disaster Communication Network (NDCN)

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[53] *National Disaster Management Guidelines- National Disaster Management Information and Communication System (NDMICS) 2011. A publication of the National Disaster Management Authority, Government of India ISBN: 978-93-80440-12-5, February 2012, New Delhi*

[54] *Disaster Management Continuum: Diagram advised by NPDM 2009*

for transporting the value added information to the stakeholders.

4.29 **National Disaster Communication Network.** The communication network between the national and the state EOCs and the site of the emergency/crises are currently based on the DOT network. It has been observed that in a calamity/hazard, communication is the first casualty. Therefore, NDMICS proposes to establish NDCN which would be a "***network of networks***" created by leveraging all existing terrestrial and satellite communication networks including NICNET, SWANs, POLNET, DMNET (ISRO) etc that would be connected to various Emergency Operation Centers (EOCs) at National (NEOC), State (SEOCs) and Districts (DEOCs) Levels through appropriate routers and gateways.

4.30 **National Emergency Operation Centre.** To coordinate the entire disaster / emergency operations effectively, the existing Control Room at the national level has been being upgraded as National Emergency Operations Center (NEOC). The National EOC is equipped with satellite phones, GPS, computers, emergency lights, GIS information system etc. at five on-site emergency coordination kits in ready-to-use mode and is located in New Delhi, under the aegis of MHA.

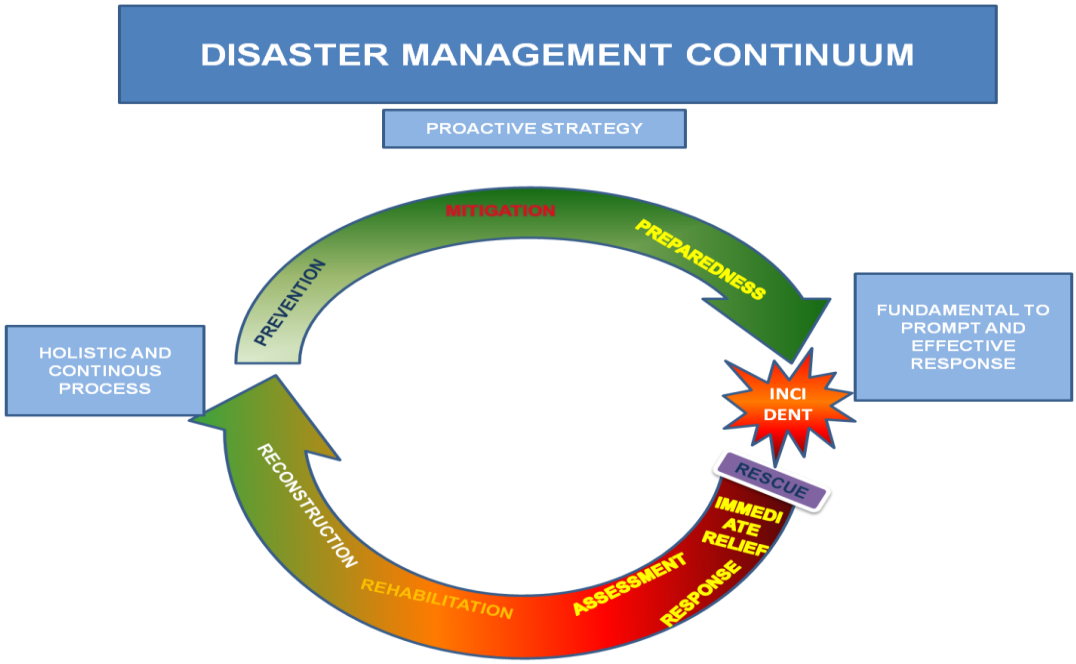

Fig 4.1

Fig: Disaster Management Continuum: Diagram advised by NPDM 2009

4.31 **Strengthening of Fire Services.** In order to further strengthen the capacity for response, the fire services are being planned to be developed into multi hazard response units as is the normal practice in several other countries.

4.32 **Strengthening of Civil Defence.** India has a large network of Civil Defence and Home Guards volunteers. The existing strength is about 1.2 million. However, this organization has not so far been associated with disaster mitigation, preparedness and response functions. A road map to revamp of the Civil Defence organization to enable them to discharge a key responsibility in all the facets of Disaster Management including preparedness has been drawn elaborately by the GoI. Mock drills are being conducted regularly in all the states with active participation of central forces.

4.33 **Corporate Social Responsibility (CSR) and Public-Private Partnership (PPP)[55].** Historically, the corporate sector has been supporting disaster relief and rehabilitation activities. However, the involvement of corporate entities in disaster risk reduction activities is not significant. CSR in India was an activity that was performed but not deliberated. In order to streamline the philanthropic activities and ensure more accountability and transparency, the GoI made it mandatory for companies to undertake CSR activities. The Ministry of Corporate Affairs notified Section 135 and Schedule VII of the Companies Act 2013 as well as the provisions of the Companies (Corporate Social Responsibility Policy) Rules, 2014 to come into effect from April 1, 2014 which stipulates that every company whose profits are above 5 Cr or having a turnover of more than 1000 Cr or having net worth of 500 Cr or more, during any financial year needs to spend at least 2% of its average net profit for the immediately preceding three financial years on CSR activities.

4.34 Corporate entities should redefine their business continuity plan to factor in hazards, risks and vulnerabilities. They should also create value in innovative social investments in the community. In order to promote CSR, the GoI has also permitted certain Tax relief under the existing IT Act. Similarly, PPP between the Government and private sector would also be encouraged to leverage the strengths of the latter in disaster management. The NDMA and SDMAs need to network with the corporate entities to strengthen and formalize their role in the DM process for ensuring safety of the communities.

[55] *Ref Para 5.3.4 of NPDM 2009*

(i) **Training Needs in the Field of Disaster Management[56].** The NDMA has been designated as the implementation agency in the field DM for identification, implementation and allocation of Training needs. Some of the important agencies involved in the disaster relief management both in the implementation as well as training are:-

(a) **National Disaster Response Force (NDRF).** Section 44 of Disaster Management Act 2005 created NDRF, which is a specialised force constituted "for the purpose of specialist response to a threatening disaster situation or disaster"[57]. NDRF functions under the National Disaster Management Authority. Though the DM is a state subject but When severe natural calamities of occur, the Central Government is responsible for providing aid and assistance to the affected state, including deploying, at the State's request, of Armed Forces, Central Paramilitary Forces, NDRF and such communication, air and other assets, as are available and needed. Further:-

(aa) NDRF is a force with 12 Battalions, organised on Central Para Military lines, and manned by persons deputed from the CPMFs of India; i.e., three from BSF, three from CRPF, two from CISF, two from ITBP and two from Sahastra Seema Bal. The total strength of each battalion is approximately 1149, and "each battalion is capable of providing 18 self-contained specialist searches and rescue teams of 45 personnel each including electricians, engineers, technicians,

[56] *Training Regime for Disaster Response, (Volume – I) published by National Disaster Management Authority Government of India in June 2008*
[57] *Source: Sec 44 of DM Act 2005*

masons, dog squad and medical or paramedics". NDRF in addition to being able to respond to natural disasters has four battalions capable of responding to CBRN disasters. One of the important tasks of NDRF is to continuously engage themselves in the community capacity building and public awareness programmes, which includes training of people who are the first-responders and government officials concerned, at different levels of responsibility.

(ab) Along with capacity building and public awareness exercises, NDRF is also proactively involved in "area familiarization exercises" at frequent intervals to understand topography, access and escape routes and accessibility to the local expertise. **NDRF has so far trained more than 50 Lakh volunteers in various preventive aspects of disasters as they in all probability will be first responders in any disaster.**

(ac) These NDRF battalions are located at twelve vantage locations in the country created on the vulnerability profile to cut down the response time for their deployment. Additional 4 battalions are being formed for the states of Uttarakhand, Himachal Pradesh, J&K and Delhi.

(ii) Thereafter, "during the preparatory period or in a threatening disaster situation, proactive deployment of these forces will be carried out by the NDMA in consultation with state authorities

(iii) **National Fire Service College (NFSC) & National Inst of Fire Safety Engg (NIFSE) Nagpur.** These two institutes of national repute have been tasked to meet the requirements of specialized professional training in all aspects namely fire prevention, fire protection, firefighting, rescue, a specialized

emergency response in the event of a disaster. These institutions also facilitate research, documentation and consultancy services in the field of Disaster Management.

4.35 **Creation of National Disaster Response Reserve (NDRR).** The13th Finance commission recommended for creation of a NDRR in 2014 with a corpus of Rs.250 crore as Revolving Fund to meet the immediate requirement of relief material/equipment after a disaster. The purpose of creating NDRR is to mitigate the sufferings of the victims of the disaster which are beyond the coping capacity of the States. The tentative items to be kept in NDRR are tents, food, medicines, blanket, temporary shelters lighting equipment etc. The items in the inventory of relief material will be procured by the DG NDRF by adhering to the provisions of GFR and other related instructions issued from time to time by the Ministry of Finance. The cost of distributed relief materials is to be borne by the concerned State / UT so as to replenish the inventory in NDRR.

4.36 **Apada Mitra Scheme.** The NDMA has approved a centrally sponsored scheme focused on training 6000 community volunteers in disaster response in 30 most flood prone districts (200 volunteers per district) of 25 States of India under this scheme. The districts have been identified taking into account occurrence of floods in the past. The State Governments were empowered to notify the NDMA any changes in the already notified based on the threat perception. The said scheme aims to provide the community volunteers with the skills that they would need to respond to their community's immediate needs in the aftermath of a disaster thereby enabling them to undertake basic relief and rescue tasks during emergency situations such as floods, flash-floods and urban flooding. A set of standardized training modules being

developed at the national level and training institutions have been identified at the state level which will impart training to the selected volunteers from the project districts. The objectives, targets, outcomes, methodology, implementation strategy and role of stakeholders as well as the document on standard operating procedure for implementation of the scheme at the State/District level has been formulated by this organisation.

4.37 **National Disaster Management Services (NDMS).** All land based or cellular communication networks are prone to failures during disasters as were the case seen in the J&K and Uttarakhand disasters. To mitigate this problem an integrated approach has been attempted in the form of NDMS to provide reliable Telecommunication infrastructure to the disaster managers during peace time as well as in the event of any disaster. The integrated approach is part of ICT services to assist the MHA, NDMA, NDRF HQ, local administration in taking appropriate decisions. For this purpose, a pilot project titled as "National Disaster Management Services" has been conceived at 120 locations, Pan India. This is based on providing reliable VSAT communication backed up with terrestrial network and ISAT Phone. The project is being implemented by Bharat Sanchar Nigam Ltd. (BSNL). The scope of the pilot project is to provide the reliable telecommunication infrastructure and technical support for Emergency Operation Centre (EOC) functional at MHA, NDMA, NDRF HQ, States & selected vulnerable Districts.

4.38 **Mobile Radiation Detection System.** NDMA, as part of a pilot project on national level preparedness to cope with Radiological Emergencies, has taken an initiative to equip police and NDRF personnel for management of radiological emergencies in public domain. The aim is to prevent and detect any accident or

malicious act involving radioactive material as a pilot scheme, to equip the surveillance vehicles of nearly 930 police stations in all the capital cities/Union Territories, and other major cities of the country, with simple monitoring instruments and personal protective gear to detect the type of cases mentioned above and to train NDRF and states/UTs police personnel to handle MRDS equipment and disaster situations.

4.39 **National Disaster Response Force NDRF Academy at Nagpur.** In Feb 2016, the Government of India notified establishment of NDRF Academy at Nagpur as a premier institute to impart high class training to NDRF and SDRF Battalions, and also Volunteers and disaster response personnel of SAARC countries in disaster management. The KRA of this institution is to provide training on DM aspects to first responders.

4.40 **National Emergency Communication Plan (NECP).** The past experience from Odisha Super Cyclone in 1999 and Gujarat Earthquake 2001 shows that there was complete break-down of telecommunication linkages resulted in loss of invaluable time in mobilizing National & State resources for effective response to disaster. National Emergency Communication Plan was therefore created for implementation in two phases, so that reliable communication links between the decision maker and various levels and operational response team at disaster site can be set up. The aim of this plan was to envisage equipping NDRF with necessary satellite based telecommunication equipment including VSATs, transponders, satellite phones etc. for providing voice/data/video communication between the National Emergency Operation Centre and NDRF Battalions.

4.41 While the legal framework towards Disaster Prevention, Mitigation & Preparedness is in place, the need of the hour now is to implement the policies and

guidelines during an emergent situation of an impending disaster seriously. It is a known fact that there can't be universal guidelines for every disaster. It varies from place to place and communities to communities also. Keeping this in mind Shri. Narender Modi, the Prime Minister of India had listed the agenda during his inaugural speech at the Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR) 2016, which was held in New Delhi in November 2016. The all-inclusive agenda presents a holistic approach towards Disaster Risk Management and addresses a whole range of issues, from community preparedness to use of technology and international cooperation. The Prime Minister's 10-point agenda on DRR is[58]

(i) **First**, all development sectors must imbibe the principles of disaster risk management. This will ensure that all development projects – Airports, Roads, Canals, Hospitals, Schools, and Bridges – are built to appropriate standards and contribute to the resilience of communities they seek to serve.

(ii) **Second**, risk coverage for all – starting from poor households to small and medium enterprises to multi-national corporations to nation states.

(iii) **Third**, encourage greater involvement and leadership of women in disaster risk management.

(iv) **Fourth**, invest in risk mapping globally. This will help us ensure that we have a common understanding of the nature and severity of disaster.

(v) **Fifth**, leverage technology to enhance the efficiency of our disaster risk management efforts. An e-platform that brings together organizations and individuals and helps them map and exchange expertise, technology and

[58] *Source: Press Information Bureau Government of India Ministry of Home Affairs 09-January-2017*

resources would go a long way in maximizing our collective impact.

(vi) **Sixth**, develop a network of universities to work on disaster issues.

(vii) **Seventh**, utilize the opportunities provided by social media and mobile technologies.

(viii) **Eighth**, build on local capacity and initiative.

(ix) **Ninth**, ensure that the opportunity to learn from a disaster is not wasted. After every disaster, there are papers and reports on lessons learnt that are rarely applied.

(x) And **finally**, bring about greater cohesion in international response to disasters.

CHAPTER - V

KNOWLEDGE MANAGEMENT, GEOINFORMATICS, ARTIFICIAL INTELLIGENCE AND BIG DATA ANALYTICS IN DISASTER MANAGEMENT

'The explosion of Big Data has far outpaced our ability to make sense of it in poorer nations that already lack human and technical capacity.'

—Claire Melamed

5.1 **Background.** The occurrence of disasters and the losses over the years have been increasing on account of larger population and their vulnerability to natural hazards. This owes not only to the physical vulnerability i.e., their proximity to the hazard zone and ill-maintained standards of safety to counter the consequences but also thanks to the prevailing socio-economic conditions. The knowledge and experiences of disaster management specialists remain implicit to individuals or institutional domain. There is an urgent need of an organized public platform to capture, organize and disseminate this knowledge and create a versatile interface among policy-makers in the Government sector as well as the disaster administrators at all levels namely; National /State/District/Sub-District and local Communities. Knowledge management will amalgamate the technology centric organisations and strengthen ecological practices in informed decision making. There is a requirement to generate a network of knowledge institutions/platforms in the field of DM, so that their experiences and knowledge can be disseminated to the environment. Indian Scientists, some of them in collaboration with global universities, are working on potential impact scenario on climate vulnerabilities and changes in various India specific disaster zones across the nation. NIDM and other similar institutions play an important role in knowledge dissemination, data management and distribution amongst the stakeholders, other training institutions and core groups.

Disaster Risk Reduction – Role of Information and Knowledge[59]

5.2 Knowledge management is all about getting the right knowledge, in the right place, at the right time. In a broader context, information about disaster preparedness by way of SOPs, dos' and don'ts in emergency, disaster management plans, policies and guidelines are available at various domains from decades. However, millions of people are getting severely affected by disasters every year due to lack of adequate understanding or Knowledge Management in Disaster Risk Reduction mechanisms. This may be attributed to the fact that most of the information is lying dormant and is not getting disseminated into the lifesaving knowledge to the vulnerable communities and stakeholders involved in the DM process.

5.3 **Indian Approach to Knowledge Management in Disaster Risk Reduction Practice Areas.** Under the Ministry of Home Affairs, GOI - United Nations Development Programme (UNDP), National Disaster Risk Management Programme, Knowledge Networking is now seen as an opportunity to establish networks and partnership among prime government agencies, policy makers, disaster managers and specialists from allied fields of engineering, architecture, Urban planning, seismology, hydrology, agriculture and social sciences to exchange information and working together to reduce the risk of disaster. A new initiative is getting to connect all government departments, statutory agencies, research organizations / institutions to share collectively and individually their expert know-how's and domain knowledge. The exchange of such information shall be facilitated through physical interaction, workshops, documentation of experiences, sharing on Web Portal, internet, social

[59] *Knowledge Management in Disaster Risk Reduction: The Indian approach, GoI, MHA NDMA division. The document is prepared by a team comprising of Sujit Mohanty, Biswajit Panda, Hemang Karelia and Rajeev Issar under GoI-UNDP Disaster Risk Management Programme ref Para 3 Pp 7.*

media etc.

5.4 In order to evolve community of practices, the efforts are focusing at linking the program partners and providing a platform to collaborate. This collaborative platform envisaged in the form of an electronic platform will facilitate interaction among the program partners. The system shall be incentive based and deliver various user friendly tools, decision support systems, monitoring systems to the stake holders. In the first phase it shall connect all the program collaborators of Government of India comprising more than 500 institutions pan India. Subsequently conscious effort shall be made to facilitate the evolvement of various networks such as State Network; comprising all State Disaster Management Departments, Training Institution Networks comprising all Administrative Training Institutions (ATIs) and other training institutions involved in disaster management areas.

5.5 **Strengths of Knowledge Networks in Disaster Management.**

(i) Better response.

(ii) Empowered Government Disaster Management Departments.

(iii) Better valuation of Resources and services

(iv) Integration into mainstream development.

(v) Effective monitoring of initiatives.

(vi) Promoting fair practices among the disaster management community.

5.6 **The Knowledge Portal: A Tool for Knowledge Management[60].** The knowledge management initiative by the GoI encompasses a web portal to facilitate the knowledge collaboration between the network members. The portal provides tools to

[60] *Knowledge Management in Disaster Risk Reduction: The Indian approach, GoI, MHA NDMA division. The document is prepared by a team comprising of Sujit Mohanty, Biswajit Panda, Hemang Karelia and Rajeev Issar under GoI-UNDP Disaster Risk Management Programme ref Para 4.3 Pp 11.*

capture; obtain and organize the knowledge on the subject. It also facilitates location and sharing of knowledge through the portal. The portal thus provides **Knowledge Collaboration Tools** and **incentive based tools** namely:-

(i) Moderated access and facilitation.

(ii) Programme monitoring and methodology sharing tools.

(iii) Members' workspace for decentralized content management.

(iv) Powerful search engines.

(v) Moderated discussion forum for problem solving.

(vi) Document management system.

(vii) Moderated intra network e-mail groups.

(viii) Other services planned to create an incentive for the network members:

(ix) GoI, Disaster Management Programme Monitoring Tool.

(x) Disaster Risk Management Programme monitoring tool.

(xi) NPCBEERM1/ NPCBAERM2 programme monitoring tool.

(xii) Emergency contact management system.

(xiii) Database of district Disaster Management Plans.

(xiv) Map center – Hazard & vulnerability maps.

(xv) Independent workspace for States & Resource Institutions for designing and updating content.

(xvi) Automated portal administration for ease of content updating.

(xvii) There are various groupware and e-mail list servers to facilitate discussion and interaction of the network members.

5.7 These applications illustrate how Knowledge Management principles can be brought to situational awareness, sensitization, and decision-making in disaster

management practice area. In essence, knowledge organization and human knowledge conversion processes can bring a comprehensive foundation to the common operating picture, interoperability, intelligence, training and acquisitions.

5.8 As a strategic approach to achieving disaster management objectives, Knowledge management will play a valuable role in leveraging existing knowledge and converting new knowledge into action through the DM cycle. Further research and development in the subject areas of information and knowledge management technology and related domains will be needed to formulate effective disaster management systems.

5.9 **Online Inventory of Emergency Resources.** A comprehensive database of disaster management related inventory and organized information dissemination system on availability of specialised resources is extremely essential for mobilising specialised equipment and skilled human resources to respond immediately during disaster. Lack of adequate information about availability has hampered quick and measured response lead to delays in the past and again in future these will be critical during onset of any sudden contingencies. Therefore, a need to prepare a database of availability of such resources, from State to District to Mandal level is strongly felt necessary.

5.10 **India Disaster Resource Network (IDRN)[61].** The IDRN is a nation-wide electronic inventory of essential and expert resources for disaster response, covering specialist equipment, specialist manpower resources and critical supplies. One of the major challenges during the disaster phase is a professional approach towards dealing with lack of scanty inventory of resources. These delays would affect speedy response

[61] *Source: www.idrn.gov.in*

in saving critical lives of humans and livestock, therefore, a need was felt at the apex level to build an inventory of various resources which can help the district administrators and disaster managers and thus evolve the creation of IDRN. IDRN has been initiated in 2004, by Ministry of Home Affairs in collaboration with United Nations Development Program to scientifically build the disaster resource inventory as an organized information system for collation and transmission of information about the availability of specific equipment, human expertise and critical supplies database from District and State levels to provide the required resources for disaster responders for quick mobilization of the required resources within least response time.

5.11 The IDRN is a web-based resource with controlled access to the database of various inventory used in disasters. 226 items consisting mainly of equipment, human resources and critical supplies that are categorized in the system. The data related to these items are collated from the line departments and organizations from various districts. Thereafter, the data is entered in to the portal at the District level. Only the authorized Government officers have the access to ***uploaded data*** in the portal and the nominated district authorities would be authorised to facilitate data collection and updating process. The District Collectors/Magistrates are the de'facto authorized officials to get access to the latest information about disaster management resources available with various line departments/agencies. The database can be accessed and enquired by using various options available in the portal viz. country wide query, summary report, department wise report, common query, date based report etc and in coordination with NIC. The complete data is being monitored by the NIDM. NIDM is also responsible for the overall administration of this portal.

5.12 The IDRN lists out the equipment and resources by type, make, numbers and

functional aspects along with the location and addressees of the controlling officers in-charge of the said resources for easy mobilisation. The IDRN is a live system and provides updated inventory details every quarter. Entries into the inventory are made at two levels – District and State level. As this facility is a user friendly interface, the handler may avail the facilities after analysing or querying the desired information resource inventory.

5.13 **Application of Geoinformatics in Disaster Management[62].** During any emergency scenario, the role of a reliable Decision Support System and dependence on data from various sources is incredibly crucial for effective response and recovery throughout the phases of a disaster. Application of Geoinformatics tools in Disaster Risk Management is an emerging field world over. Field of Geoinformatics ***includes Remote Sensing, Geographic Information System (GIS), Global Positioning Systems (GPS) and Internet Digital Mapping Services*** that can provide the most powerful technology for every phase of disaster management i.e. hazard mapping, monitoring of onset of a calamity, risk assessment, emergency response and reconstruction phases for generating updated maps, integrating information, visualizing scenarios and identifying and planning effective solutions. Planning in any disaster management situation involves study of the spatial and temporal aspects of the location and topography. India has a huge space imaging capability, and in the last couple of decades, it is one of those countries where the technology has been put into operational applications for natural hazard mapping and monitoring. During the last decade Indian Space Research Organization initiated several programmes and projects for mapping and monitoring the landscapes, hazards and disaster prone areas. Key amongst them are

[62] *Source: Geoinformatics Applications in Disaster Management, ISRO, First Edition, 2012, Published by NIDM, MHA, New Delhi and WEB www .esri.com*

Disaster Management Support Programme (an umbrella programme to cover various initiatives related to Disaster Risk Management and Emergency Response), National Agricultural Drought Assessment and Monitoring System (NADAMS, now under DMS), INFRASS for forest fire monitoring, Bhuvan, Bhoosampada (land use, Land-cover), desertification and land degradation status mapping of India, National Wasteland Mapping, Wetland delineation and mapping and so on. Despite the tremendous potential of Geoinformatics applications in disaster management the technology has not been harnessed to its full potential by the decision makers. Ironically Geoinformatics is still considered as a research subject in our country, where tremendous advancements were made in the western countries. Disaster managers in India need to be urgently sensitized on various aspects of Geoinformatics, especially on the training and capacity building aspects of these tools. Huge investments in achieving technological milestones in this field are envisaged. Information and Communication Technologies in the form of Internet, Geographic Information System (GIS), Remote Sensing, Satellite communication etc. are crucial in planning and effective execution of most Disaster Risk Reduction initiatives. However, the potential of most advanced and cutting edge technologies are required to be exploited properly for early warning, preparedness and response systems along with adequate emphasis on capacity building. Along with remote sensing and satellite based systems (which was already covered in the previous chapter), Geographic Information System plays a significant role in the field of Disaster Management process. Some of these attributes are deliberated in the subsequent paragraphs.

5.14 GIS offers most versatile platform for holistic disaster reduction risk management towards ***Decision Support*** by providing multilayer geo-referenced data

which includes hazard zoning, availability of natural resources and critical resources, incident mapping, and critical infrastructure which are at risk, available resources for response, real time satellite imagery and mapping etc. The appropriate data, therefore, has to be collated, organized and displayed logically to determine the size and scope of disaster management programs. Towards this, GIS based information tools allow disaster managers to swiftly evaluate the impact of the disaster/emergency on geographic platform and arrange sufficient resource mobilization in a most organised way.

5.15 During an actual emergency it is critical to have the right data at the right time, presented logically, respond quickly and initiate appropriate actions without any delays. Disasters can impact all or a many of government during the disaster process. Disaster Managers often need detailed information concerning location of pipelines, buildings layout, power distribution lines and sewer lines and so on, for an effective planning of the relief and rehabilitation process. With the help of GIS tools, departments involved can share valuable information through databases on a computer generated digital maps by way of hazard mapping of any location. Without these capabilities, relief personnel have to run from pillar to post to collect the required data or gain access to the desired information. In every contingency, time is the essence. Hence, timely collection of resources is a herculean task. Emergency responders will have to resort to speculate or estimate without any real time data and make decisions without adequate information. This costs time, money, and in most of the cases valuable lives. GIS provides an apparatus to centralise and visually present critical information during an emergency on a platter. Most of the data requirements for disaster management are of a spatial nature which can easily be located on a digital

map. GIS can fulfill data requirement needed for planning a disaster operations which can become the mainstay during disaster management process. Disaster management activities therefore, are focused on three primary objectives. These objectives are safeguarding lives, property and the environment & ecosystem. In order to achieve these objectives, following basic processes are essential.

(i) ***Planning of Disaster Management Programs*** begins with locating and identifying potential problems in a disaster situation. Using a GIS, administrators can pinpoint hazards and begin to evaluate the consequences of potential emergencies or disasters. When hazards (like earthquake faults, fire hazard areas especially forest fires, flood zones, oceanfront areas exposure, etc.) are viewed with other map data (streets, pipelines, buildings, residential areas, power lines, storage facilities, etc.), officials involved with DM can begin to formulate mitigation, preparedness, response, and possible recovery requirements. Administrators can focus on where mitigation efforts will be necessary, where preparedness efforts must be focused, where response efforts must be strengthened, and the type of recovery efforts that may be necessary. Before an effective DM program can be implemented, thorough analysis and planning must be done. GIS assists this process by letting planners to identify the appropriate combinations of spatial data through computer-generated maps.

(ii) ***GIS Technologies can be effectively used***[63] in Disasters and Emergency Management. Mitigation as potential emergency situations can be identified; mitigation needs can be determined and prioritized through the tools of GIS. For example, lets introspect the case of an earthquake:-

[63] *GIS Technology for Disasters and Emergency Management by Russ Johnson printed and published by Environmental Systems Research Institute, Inc., 380 New York Street, Redlands, CA , USA*

(a) What changes are required to be within the primary impact zone of earthquake faults?

(b) What kind of damage may occur based on the expected magnitude of an earthquake, characteristics of soils and other geologic data?

(c) What facilities are required to reinforce construction or relocation?

(d) What kind of infrastructure are there in high hazard areas like important bridges, primary roads, freeway overpasses/underpasses, hospitals, hazardous material storage facilities, military hardware, oil dumps etc?

(aa) Mitigation may include implementing legislation norms, (for example ensuring building norms, building codes, and specific usage of certain materials during construction, fire and explosive clearances etc) that limits building in earthquake or flood prone zones. Values at risk can be displayed quickly and efficiently through a GIS mapping. Utilizing existing databases linked to geographic features in GIS makes this promising. GIS tools can identify various soil types in and adjacent to earthquake impact zones; where bridges or overpasses/underpasses are at risk. GIS can also identify the likely path of a flood or cyclones based on topographic features, contours and slopes; based on water currents and wind pattern. Considerable human lives and other valuables like property, habitat, wildlife, etc. which are at risk from these emergencies can be quickly identified and targeted for initiating protective as well as preventive action. Similarly, GIS can also identify specific slope categories in combination with certain species of

flammable vegetation near homes or forests, factories or refineries that could be a potential fire hazards including wildfires.

(ab) Preparedness includes those activities that prepare for actual emergencies. GIS can provide solutions to queries such as ***Where should fire stations be located if a five minute response time is available? How many medical emergency centers are required and where should they be located? What evacuation and escape routes should be selected if a toxic cloud or fumes are accidentally released or leaked from a plant or storage facility, where wind direction is very critical? How will people be warned? Will the road networks handle the quantum of traffic, especially in the wake of floods or cloud burst? What facilities are required in evacuation shelters? What quantity of relief supplies, floor mats and blankets and so forth, will be required at each shelter based on the number of expected evacuees?*** **GIS now has answers to all these**. GIS can demonstrate real-time monitoring of emergencies as well as can provide early warnings. Remote weather stations can offer current weather pattern like wind direction, temperature and relative humidity based on location and synoptic progression of affected as well as surrounding areas. Wind information at various levels is significant in predicting the movement of a chemical or nuclear cloud; or forecast of the direction of wildfire etc. Similarly, tectonic plate movements during earthquakes, reservoir level at dam sights during floods, radiation monitors during NMC holocaust etc., are some of the derivatives of GIS application. This

information can now be uploaded and delivered to public, disaster manager and other stakeholders at lightning speeds through the internet portals and social media like Twitter or WhatsApp.

(ac) **Response.** GIS can provide one of the key components for computer aided dispatch systems. Disaster response units based at any locations can be identified and routed for emergency response. The closest or quickest response units can be identified, selected, routed, and dispatched to an emergency site once the location is known. Depending on the gravity of the situation, a GIS tool can provide detailed information to the initial responders before they actually arrive at the site. For example, during a commercial building fire, it is possible to identify the closest hydrants, electrical panels, hazardous materials and details of floor plan along their exit routes of the building while enroute to the emergency. Similarly, for hazardous spills or chemical cloud release, the direction and speed of movement can be worked out to determine evacuation zones, direction of combat operations and containment needs. Information regarding the identification and availability of critical facilities like location of rehabilitation material; position of connected departments, agencies involved with DM processes, certain heavy machinery and equipment; particularly; power tools, cutting appliances and excavation transport vehicles that would come handy during the mitigation of earthquakes or flash floods .

5.16 GIS application allows identification of needs prior to the onset of any occurrence of a disaster. Massive Disasters such as tsunami, floods, earthquakes, wildfires, cyclones,

epidemics, chemical cloud dispersion, CBRN emergencies and oil spills, can be modeled and displayed in GIS. DM administrators can use GIS modeling for training, for actual tactical deployment during a disaster, mapping of high risk areas or to analyse the consequences of a possible disaster. Varied applications of a GIS thus, can give a big relief and possibly can avoid panics during handling of any enormous emergencies. Towards this, it is heartening to note that the Indian Air Force has already launched a project to digitize the maps of all their bases depicting all the vital information on them.

Role of Big Data Analytics and Artificial Intelligence in Disaster Management.

5.17 **Big Data Analytics.** Technological innovations and advancements can create new opportunities for supporting disaster resiliency and risk reduction actions in any country. Computer generated Data, information from various sensor networks; Data from Remote sensing satellites etc plays a vital role in mitigation in Disaster Management. Big Data Management and Analytics of Big Data thus, play a vital role in DM process. ***Big Data*** represents the analysis of high volume, complex, high velocity, and variety of data required through machine learning and analytical methods for transformation in to values. Information, derived from Data Analytics is invaluable and can save life and property, reduce economic loss and help to enhance resilience for disasters. The growing emphasis on increasing resilience has occurred during the beginning of this century, at roughly the same time as the emergence of 'Big Data'. We conceptualize Big Data, not just as large data base, some of which have been used for decades in climatology, but as a new socio-technological phenomenon resulting from the emergence and development of an ecosystem made up of the new kinds of data '***Crumbs'*** about human behaviors and beliefs generated and collected by digital devices and services, ever more powerful computing power and analytics tools, and a vibrant community of participants in the field

of DM. Time is ripe now to explore these challenges, opportunities and required steps for catapulting this new ecosystem of ***Big Data,*** **(**though relatively at its early stages of development) which can be used to monitor and detect hazards, mitigate their effects, and assist in relief efforts. Eventually, the aim is to build resilience so that vulnerable societies, which are complex human ecosystems, not only **bounce back** but also learn to adjust and maintain **equilibrium** in times of natural hazards. An overall inference is that Big Data, as with nearly everything associated with Big Data is still "in its intellectual nascent stage and operational infancy". Today, most existing applications are small pilot projects, though few formal evaluations do exist, and much of the field consists of studies from the grey and white literature, case studies, and reports from NGOs, humanitarian organizations, academic institutions, researchers and private companies. However, results indicate that Big Data does show real value, promise and potential as a force for increasing social resilience, provided it is approached and promoted positively. Generally speaking, Big Data can have four main roles or functions in disaster-prone regions:[64] **:-**

(i) Descriptive, involves narrative or early detection such as using data from satellite imagery to identify flooded areas or identifying areas in need from crisis maps;

(ii) Predictive, includes what has been called 'now-casting' - to make real-time inferences on population distribution based on mobile-phone activity before, during or after a shock as well as forecasting sudden and slow onset hazards equally;

[64] *Realising the Benefits for Developing Countries; Sept 2015 & http://www.datapopalliance.org/projects ; Data-Pop Alliance Synthesis Report on Big Data for Climate Change and Disaster Resilience*

(iii) Prescriptive (or diagnostic), goes beyond description and inferences to establish and make recommendations on the basis of causal relations, for instance by identifying the effects of agricultural diversification on resilience;

(iv) Discursive (or engagement), concerns stimulating and shaping dialogue within and between communities and with key stakeholders about the needs and resources of vulnerable populations such as crowdsourcing maps to assist disaster relief processes.

How Big Data Can Help?

5.18 This growing emphasis on increasing resilience has occurred roughly at the same time as the emergence of 'Big Data', probably at the beginning of 2000s, and is being conceptualize as an ecosystem made up of three factors: ***digital data from sources as diverse as satellites and mobile phones, the capacity to analyse and use that data, and the people who produce, analyse, and/or use the data.*** Big Data has opened up promising approaches to disaster resilience and in a way plays an important role in all the phases of DM viz., ***Disaster Preparedness***, ***Disaster Response, Disaster Recovery and Disaster Mitigation.*** However, as mentioned earlier, Big Data application is relatively a new field. Many challenges exist in the appropriate usage of Big Data application. Most of the policy makers and agencies involved with DM are alien to this subject hence they ignore these tools in the decision process. Many western countries rely on Big Data along with **AI** and machine learning for the forecast of many natural hazards like Cyclone/Hurricanes and flood warnings, Tsunamis, Lightning, Storms, Avalanches, Forest fires etc for high accuracy and reliability. Big Data analytics holds enormous potential for Disaster Management in India too. In future, Big Data and **AI** are going to be key drivers behind the ongoing digital transformation pan India, and

will play an increasingly important role in all phases of disaster management and resiliency development. Examples include the analysis of causalities to determine the requirement of medical assistance, use of financial transactions to monitor economic activity during and after a disaster in order to improve targeting of support efforts, pattern of calamities etc for mitigation aspects, to identify communication patterns during disasters, through the analysis of social media etc are some of the applications of Big data. The use of Big Data to build resilience generally falls into ***one of the five categories*** throughout the disaster cycle, which rely on the four functions of Big Data described above. These five categories are[65]:-

(i) **Monitoring Hazards.** Seismographs, satellites, and drones present ever-improving remote sensing capabilities. Adding data from citizens' smartphones or information from their Twitter feeds offers tremendous potential for monitoring the progress during earthquakes and floods.

(ii) **Assessing Exposure and Vulnerability to Hazards.** Satellite imageries allow experts to identify geographical and infrastructural risks. With latest updates on Google maps, volunteers can now add real time data that are useful for updating and verification purposes.

(iii) **Guiding Disaster Response.** Social media can be monitored to provide early warning on threats ranging from disease outbreaks to food insecurity. Remote sensing has been used to provide early assessment of damage caused by

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65 *source : Data-pop Alliance Synthesis Report on Big Data for Climate Change and Disaster Resilience: Realising the Benefits for Developing Countries; September 2015 & http://www.datapopalliance.org/projects*

cyclones and earthquakes. Mobile phone data can provide precious information on population movements and behavioral response after a disaster.

(iv) **Assessing the Resilience of Natural Systems.** Satellite images revealing changes in, for example, soil quality or water availability can be used to inform agricultural interventions in developing countries. Citizen reporting via social media and other platforms can radically expand observations and ecological systems data base.

(v) **Engagement of Communities.** Building long-term resilience takes more than enhancing the ability of both external and local agencies to react to single events. Resilient groups manage their natural systems, strengthen their infrastructure, and maintain the social ties and networks that make communities strong. The long term potential of Big Data lies in its capacity to raise citizens' awareness and empower them to take appropriate actions, though the decisions that facilitate or hinder this capacity are essentially political ones.

5.19 **What is the Road Map for Big Data?** The proven or potential benefits of Big Data has not yet translated into a clear roadmap indicating practical ways to build disaster resilience on the scale necessary to counter the risks faced by the world's most disasters. Fixing this gap requires huge investments in Big Data technologies, in the communities that support and use these technologies, and in the future of the field as well. Within these three main areas, this report identifies the following **12 priorities:-**

(i) **Invest in Big Data Technologies.** Many cutting-edge technologies have huge potential but need to be tested, refined and validated in the field to scale-up.

(ii) **Get early Warning Systems and Risk Maps into the Hands of the People who can use them**. Techniques to handle crisis data from satellite

imageries and the Internet already exist. However, Interface between Human-Centered Design and wide dissemination would make these models more beneficial to all the stake holders.

(iii) **Invest in Basic Forms of Existing Applications that have High Returns.** Such as social media, mobile call record data, Facebook, twitters and crowd sourced approaches that combine machine and human computing.

(iv) **Identify High Value-Add Contexts.** An example of a high value-add context is vulnerable populations in the disaster prone areas that are experiencing the greatest increase in disaster risk and, simultaneously, rapid growth in mobile and social media technology.

(v) **Facilitate the Proper Management and use of Existing Big Data Resources.** Vital Data can be released quickly during crisis by developing data sharing guidelines and common standards as well as design of innovative models and partnerships.

(vi) **Shift to an Integrated "Data Portfolio" Approach.** The most promising use of Big Data is the capability to combine data from a variety of sources. The effectiveness of resilience strategies will therefore, be shaped by the value of the data portfolio as a whole and not by individual technologies.

(vii) **Invest in Big Data Communities.** Communal learning and a shared understanding of risks and opportunities are important factors of resilience. People, as much as the technology, drive the success of Big Data innovations. To build resilience, investments should focus on:-

(a) **Facilitating Coordination among Stakeholders.** For example, fostering regional data ecosystems around key actors and activities to link

grassroots groups and start-ups with large corporations, organizations and agencies.

(b) **Spurring Dialogue on Ethics and Privacy.** It is possible if there is a synergy between public officials and civil society organizations. if the same can be understood for addressing privacy, political and associated legal risks;

(c) **Promoting and Incentivizing Private Sector Involvement.** via the organization of data challenges and promotion of financial and in-kind support to local start-ups and organizations;

(d) **Spurring Data Literacy.** Big Data for resilience should not be left to experts only; a major requirement is to enhance people's willingness and ability to engage with and via Big Data to shape the future of the field.

(e) **Invest in the Future of the Field.** The field of Big Data for resilience is still at nascent stage but it is growing rapidly. Investments in this field can have big payoffs for developing communities and the humanitarians who serve them in future. Steps should be taken to:

(aa) **Facilitate Feedback in the Disaster Response Community.** To enable researchers and humanitarian agencies to share new knowledge and best practices, a simple mechanism may be developed.

(ab) **Tap Mobile Phone Data more Optimally and Rapidly.** Mobile phones are a critical technology entry point for people in developing countries including India. But the data infrastructure and processing of mobile phone data capability still lag behind.

(ac) **Synchronize Big Data Sources.** By combining mobile call data, social media data and Internet data, policy makers can be sensitized of ever changing disaster dynamics. For example, updated demographic data for risk assessments can be predicted. It may be noted here that much of the return on investment in the use of Big Data for resilience in future revolves around by simply analysing the existing data before the next disaster hits.

5.20 **Application of Science and Technology in Disaster Management.** In an increasingly interconnected world, Disaster and Emergency risks are getting more complex and inflexible. Therefore, it is important that we optimize the application of Science and Technological capabilities to appreciate, reduce and mitigate disasters and emergency risks. The NDMA is doing a commendable job in reaching out to the scientific community and working towards a futuristic agenda for the disaster risk Management in the country. Over the past 20 years, science & technology has brought a deeper understanding as to of how the disasters are created and how they can be managed. This is evident from the giant strides in several areas we have taken towards forecasting extreme climatic and weather conditions thereby forewarning the people and DM agencies likely to be affected or involved. This will go a long way for an effective planning of contingencies by way of evacuation procedures, augmentation of resources for recovery and rehabilitation activities. While the existing framework of application of science and technology is on right direction, the emergence of new sciences and technologies like Artificial intelligence, Robotics, Big Data Analytics, Geo sciences needs to be explored optimally to cater to the next generation Disaster Risks, while the traditional methods of satellite imagery and seismometers continues to

remain important methods for detecting, monitoring and accessing disasters.

Application of Artificial Intelligence (AI) in Disaster Management[66]

5.21 Machine learning algorithms are increasingly generating invaluable insights about a variety of occurrences. This aids computers to emulate human intelligence; hence the term ***Artificial Intelligence***. **AI** can have remarkable impact for disaster management, from potentially predicting of earthquakes, cyclones, floods, lightning etc., to hasten recovery and response periods during the process. Philanthropic groups are hoping to speed up map creation by using machine learning in computer software to extract objects such as buildings and roads from aerial images. Considerable research effort is currently being devoted to the use of **AI** for detecting and maybe one day predicting earthquakes accurately. **AI** does not need to be costly, freely available programming languages can execute equations regarding meteorological observations for better predictions. Recent progresses in machine learning and artificial intelligence are allowing researchers, engineers, and scientists to access and analyze new and bigger data sources than ever before. Researchers are confident that the future of Disaster Management would largely depend on the applications of **AI** tools. **AI** can predict occurrence of various disasters with great accuracy, which could make a difference between life and death for thousands of vulnerable communities. The primary strength of **AI** is the way it increases our capacity to predict, and therefore plan for, events and circumstances. ***AI as a kind of machine intelligence which has the ability to correctly interpret, interpolate & extrapolate external data, to learn from such data, and to use that knowledge to achieve certain goals and tasks through flexible adaptation.*** **AI** is a system that can perform tasks which otherwise require

[66] *https://www.abbeycode.com/blog/2019/12/13/artificial-intelligence-definition-amp-basics; Auth: jon Bossman Dec 13, 2019*

human intelligence; Many of these artificial intelligence systems are powered by machine learning. **AI** often revolves around the use of algorithms, which is a set of definite instructions that a computer can execute. A complex algorithm is often built on top of another simpler algorithm. Many **AI** algorithms are capable of learning from the data; which can enhance oneself by learning new strategies, or dimensions that were proved in the past or can themselves re-write new algorithms. Considering that the most important methods to save lives in disasters is to have early warning, there's a lot of good the **AI** can do. Governments and relief agencies in the advanced countries are beginning to use these tools to coordinate better disaster relief programs. For example, large-scale behavior and movement data, run through predictive machine learning models, can help officials distribute supplies to where people are going, rather than where they were. Predictive analytics programs like these are still in their nascent stages, but offer a promising new approach to disaster relief. Use of **AI** in disaster mitigation will help the relief agencies analyze through large volumes of complex, fragmented data to generate valuable information that they can act on more quickly than before. Artificial intelligence has numerous potential advantages in making predictions, identification of damages by analyzing the satellite images of impassable roads, flood water flow, building states and making it a suitable solution to use in disaster management. In fact post Nepal earthquakes in 2015, NGOs and relief groups used pre-and post-disaster imagery and utilized crowd sourced data analysis and machine learning to identify locations affected by the quakes that had not yet been evaluated or received relief. This show how important is the **AI** tools in the recovery process as well. Tools of **AI** can spread key information more quickly, better appreciation of the causes of disasters, improve early warning systems, inexpensive,

evaluate damage in new ways and add to the knowledge base of the social behaviors and economic impacts post disaster crisis. Situational awareness is improving with new tools enhancing the clarity to the disasters prone communities, so that the mitigation process can be prioritized. Robots, sensors or drones using **AI**, can help first responders and rescue workers quickly in assessing the situation as well as, initiating a suitable action plan for saving trapped victims. It also makes rescue efforts less time-consuming, safe and properly coordinated.

5.22 Some of the natural disasters that can be predicted by using the tools of **AI** and Machine Learning are [67]:-

(i) **Earthquakes[68]. AI** systems and tools can be used with the help of large seismic data to analyze the magnitude and patterns of earthquake; predict the possible epicenters and aftershocks. **AI** can significantly improve earthquake analysis; not only with the support of large data volumes, but also if only a limited dataset is available. The assessment of the recorded seismograms helps determine the possible occurrence of a quake. Conventionally, this is a manual procedure and can often be influenced by subjectivity of the seismologist in charge. Significantly, manual evaluation requires lot of time, efforts and staff resources for analysis of huge quantum of seismic data. Computerized evaluation has become necessary in order to leverage all available data quickly. However, algorithms developed so far are not able to deliver the precision

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[67] *https://www.forbes.com/sites/cognitiveworld/2019/03/15/how-ai-can-and-will-predict-disasters/How AI Can and Will Predict Disasters: Contributor Naveen Joshi; Contributor Group- COGNITIVE WORLD*

[68] *https://qrius.com/heres-how-artificial-intelligence-will-assist-in-identifying-aftershocks-of-earthquakes/ : Here's how AI will help identify earthquake aftershocks by Elton Gomes published in 31 Aug 2018*

achieved due to extreme complexity of the formation and propagation of earthquakes. Notwithstanding the complexities, Harvard University's engineering and earth sciences departments have used artificial intelligence to amplify the sensitivity of the United States earthquake detectors, otherwise known as seismographs. Machine learning is used in seismographs, cancel the normal geological rumblings of the Earth (what's known as "ambient seismic noise") to spot the earthquakes that might be very small or far away. In a paper published in 2018 in the journal *Science Advances*, they show how effective this technique is, which is capable of sensing 17 times more earthquakes than by the conventional method that too in a fraction of the time.

(ii) **Cyclones.** Every year cyclones leaves thousand dead, injured and cause property damage worth crores of rupees. Meteorological departments world over are looking for better techniques to predict natural disasters like cyclones which ravage the vast coastal areas (especially India and Bangladesh) and track their path and intensity. With more effective forecasting techniques, the authorities concerned can save more lives and minimise property damage. In Aug 2017, NASA tracked Hurricane Harvey, using satellite images and machine learning. The method proved to be six fold better than the standard technique, as the hurricane now can be tracked every hour instead of every six hours with conventional methods. Therefore, the developments in technology are helping in monitoring hurricanes and foreseeing the trail of hurricanes, which will assist and hasten the mitigation efforts. Similar techniques can also be used in the Indian context for mitigating cyclones.

(iii) **Floods.** Various researchers and engineers, including Google are

building an **AI** platform to predict and forecast floods by collating rainfall data, volumes of water at the catchment areas, wind and temperature pattern along with flood simulation to predict and monitoring floods. In fact Google has already announced that it will collaborate with Central Water Commission of India on **AI**, to alert people in India about impending floods. **AI** can predict floods better than the traditional systems. **AI** can also be used to monitor urban flooding by using a combination of machine learning, rainfall data, images and information about the locations, bottlenecks, narrow lane information, topography & contours, elevation of area, building & population density in a locality that can be modeled and fed in to the system that can be recognized by the **AI**. With this information and data in hand, systems are often programmed to create river flood forecasting models more accurately; predict not only when and where a flood might occur, but the severity of the event can also be forecasted as well.

(iv) **Lightning.** Scientists have developed a simple and inexpensive **AI** system that can predict when lightning will strike any place within 30 kms radius, up to 30 minutes in advance[69]. Lightning is one of the most unpredictable phenomena in nature, which kills hundreds of people and animals every year and triggers forest fires around the world. Little is known about what triggers lightning, and there is no simple technology for predicting when and where lightning will strike, noted the researchers from Ecole Polytechnique in Switzerland. The new system, described in the journal – Climate and Atmospheric Science, uses a combination of standard meteorological data and **AI**. Current predictions are based on the analysis of complex data acquired by the satellites

[69] *Source-ToI, Hyd edition Dt 09 Nov 2019*

and Radars, which not only time consuming but also error prone. The new method using the **AI** and machine learning algorithms can be trained to recognize the conditions that lead to lightning by acquiring the real time data easily from any weather station in the vicinity of storm. Once the data is computed through **AI**, predictions can be made quickly, and alerts can be issued even a storm has formed. Researchers revealed that machine learning model was able to warn and predicted lightning with near accuracy up to 30 minutes in advance and in area around 30 Kms from the observation point. Four parameters were taken into account-Atmospheric pressure, air temperature, relative humidity and wind speed. The researchers thereafter correlated the parameters with recordings from lightning detection and location system. Using the method, the algorithm was able to learn the conditions under which lightning occurs. Once trained, the system made predictions that proved correct almost 80% of time.

5.23 The above mentioned applications amply illustrate how Knowledge Management guidelines & principles can be brought to create situational awareness, sensitize and hasten decision-making process in the field of disaster management practice areas. The quintessence, knowledge institutes and human knowledge transformation processes can bring a comprehensive change to the common operating procedures, interoperability, judgmental values, training and achievements. *As a strategic ap*proach to achieving disaster management objectives, Knowledge management will play a key role in influencing the existing knowledge and transforming new knowledge into action through the Knowledge Management cycle. Since it is a continuous process, more research and development in the above discussed subject areas and related domains will be needed to further enhance the effectiveness of Disaster Management Systems.

CHAPTER - VI

CASE STUDIES OF SOME MAJOR DISASTERS THAT STRUCK INDIA

INDIAN OCEAN EARTHQUAKE AND TSUNAMI: 26 DECEMBER 2004

6.1 Prior to 2004, Tsunamis were not considered a high-risk hazard, certainly not outside the Pacific Ocean. Tsunami science was relatively a new scientific field, with little application of knowledge into practice as it rarely occurs. Scientists in fact published work on a possible ocean-wide tsunami in the Indian Ocean, a few months before the actual occurrence of Tsunami in 2004 event[70]. With rapid population growth of coastal communities in the region, the scene was ideal for catastrophic consequences for the Indian Ocean Tsunami in 2004.

6.2 The Indian Ocean Tsunami, called **Sumatra-Andaman** earthquake by the scientific community also colloquially called "Boxing Day Tsunami" occurred at 00:58:53 UTC on 26 December 2004, with an epicenter, off the west coast of northern Sumatra, Indonesia. It was an undersea mega thrust earthquake that registered a magnitude of 9.1-9.3 Mw, reaching a Mercalli intensity *(which is a seismic intensity scale used for measuring the intensity of shaking produced by an earthquake. It measures the effects of an earthquake at a given location, distinguished from the earthquake's inherent force or strength as measured by seismic magnitude scales)* up to IX in certain areas. The earthquake was caused by a rupture along the fault between the Burma Plate and the Indian Plate, thus causing the great Tsunami in the Indian Ocean.

[70] *Cummins P, Burbidge D. Small threat, but warning sounded for tsunami research. AusGeo News. 2004; 75:4-7.*

6.3 A series of large Tsunami waves up to 30 meters high were created by the underwater seismic activity. Inhabitants along the coastlines of the Indian Ocean were seriously affected, killing an estimated 227,898 people in 14 countries. The largest number of victims was reported from the coastal Indonesian city of Banda Aceh. It also caused major disruptions to living conditions, trade & commerce, particularly to the economies of Indonesia, Sri Lanka, India, and Thailand. Many international organisations offered prompt relief and humanitarian aid to the affected countries.

6.4 This earthquake was the third largest ever documented and had the longest duration of faulting ever witnessed; that is between eight and ten minutes. It shook the earth and caused the planet to vibrate as much as 10 millimeters and it remotely triggered earthquakes as far away as few places in the United States and Alaska.

6.5 The 2004 Indian Ocean earthquake invoked a lot of debate as to the intensity of the earthquake. While the initial recording was to the magnitude of 8.8, the scientists kept on revising it. In 2005, Feb the estimates was 9.0 magnitude, while the United States Geological Survey has maintained its estimate of 9.1. A 2006 study estimated a magnitude of Mw 9.1-9.3; Hiroo Kanamori of the California Institute of Technology estimated that Mw 9.2 is representative of the earthquake's size. The Pacific Tsunami Warning Center however, has accepted these new numbers,

6.6 The ***Epicenter*** (3°18′58″N 95°51′14″E) or the ***Hypocenter*** of the main earthquake was approximately 160 km off the western coast of northern Sumatra, in the Indian Ocean just north of Simeulue Island and mainland Sumatra at a depth of approximately 30 km below mean sea level (though initially it was reported as 10 km). The northern section of the Sunda mega thrust ruptured over a length of 1,300 km. Splay faults, or secondary "pop up faults", caused long, narrow parts of the sea floor to swell up in

seconds. This quickly elevated to the peak and increased the speed of waves, destroying the nearby Indonesian town of Lhoknga. The effects of earthquake followed by the giant Tsunami tidal waves mainly were felt in ***Bangladesh, India, Malaysia, Myanmar, Thailand, Sri Lanka and the Maldives***[71].

6.7 The earthquake was the third largest ever recorded and had the longest duration of faulting ever observed; between eight and ten minutes[72]. It caused the planet to vibrate as much as 10 millimeters and it remotely triggered earthquakes as far away as Alaska. In the last one hundred years, the only earthquakes recorded with a greater magnitude were the 1960 Great Chilean earthquake with a Magnitude of 9.5 and the 1964 Good Friday earthquake in Prince William Sound with a Magnitude of 9.2 Mw. The only other recorded earthquakes of similar magnitude of 9.0 or greater were off Kamchatka, Russia, on 04 November 1952 with 9.0 Mw and Tōhoku, Japan with 9.1 Mw in March 2011. Each of these mega thrust earthquakes also spawned Tsunamis in the Pacific Ocean. However, as compared to the 2004 Indian Ocean earthquake, the death toll from these earthquakes was significantly less, mainly because of the lesser population density along the coasts, superior earthquake resistance infrastructure and superior warning systems in the More Economically Developed Countries such as Japan, USA etc.

Energy Released[73]

6.8 The energy released on the Earth's surface ($\mathbf{M_E}$, which is the seismic potential for damage) by this earthquake in the Indian Ocean was estimated at 1.1×1017 joules. This energy is correspondent to over 1,500 times that of the Hiroshima atom bomb; however,

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[71] *Nalbant, Suleyman S.; Steacy, Sandy; Sieh, Kerry; Natawidjaja, Danny; McCloskey, John. "Seismology: Earthquake risk on the Sunda trench" publishe by. Nature Magazine on 9 June 2005.*

[72] *"Analysis of the Sumatra-Andaman Earthquake Reveals Longest Fault Rupture Ever". National Science Foundation. 19 May 2005.*

[73] *USGS: Measuring the size of earthquakes". Earthquake.usgs.gov. 27 October 2009.*

the total energy thus released by the quake was 4.0×1022 joules (40 ZJ), the vast majority was underground, which is over 360,000 times more than its $\mathbf{M_E}$, equivalent to 9,600 gigtons of TNT equivalent (550 million times that of Hiroshima) or about 370 years of energy usage of the USA; which translate to the energy levels of 1.08×1020 joules (108 EJ). The only earlier documented earthquakes with a larger MW were the 1960 Chilean and 1964 Alaskan quakes, with 2.5×1023 joules (250 ZJ) and 7.5×1022 joules (75 ZJ) respectively.

6.9 The earthquake generated a seismic oscillation of the Earth's surface of up to 200 - 300 mm equivalent to the effect of the tidal forces caused by the Sun and Moon. The seismic waves of the earthquake were felt across the planet; as far away as the U.S.A in the state of Oklahoma, where vertical movements of 3 mm were recorded. By February 2005, the earthquake's effects were still detectable as a 20 μm (0.02 mm; 0.0008 in) complex harmonic oscillation of the Earth's surface, which gradually weakened and merged with the constant free oscillation of the Earth more than four months after the earthquake[74].

6.10 The sudden rise of the seabed by nearly 40 meters during the earthquake displaced enormous volumes of water, resulting in a Tsunami that majorly struck the coasts of the Indian Ocean. A Tsunami that causes damage far away from its source is sometimes called a TeleTsunami and is much more likely to be produced by vertical motion of the seabed than by horizontal motion[75].

6.11 The Tsunami, like all others, behaves differently in deep water than in shallow water. Tsunami waves form only a low, broad hump, barely noticeable and harmless In deep ocean bed, but gains momentum and high speed ranging between 500 and 1,000 km/h

[74] *Sibuet, J. (15 Nov 07). 26th Dec 04 great Sumatra–Andaman earthquake: Coseismic and post-seismic motions in northern Sumatra*

[75] *Fury of Natural Disasters by Nancy Williams published by Nimby Books, in Jan 2010*

in shallow waters near coastlines, sweeping virtually everything enroute. A Tsunami slows down to only tens of kilometers per hour but, in doing so, forms large destructive tidal waves along the path. Scientists exploring the damage in Aceh town in Indonesia, found evidence that the Tsunami tidal waves have reached a height of 24 meters when coming ashore along large stretches of the coastline, rising to 30 meters in some areas when traveling inland. Radar satellites recorded the heights of Tsunami waves in deep water: maximum height was at 600 millimeters two hours after the earthquake, the first such observations ever made[76].

6.12 According to Tad Murty, Vice-President of the Tsunami Society[77]; the total energy of the Tsunami waves was equivalent to about 5 megatons of TNT (21 PJ), which is more than twice the total explosive energy used during all of World War II (including the two atomic bombs) but still a couple of orders of magnitude less than the energy released in the earthquake itself. In many coastal areas the waves reached as far as 2 km inland, including in Carnicobar Island in the Andaman archipelago. As the 1,600 km fault line affected by the earthquake was in a North-South orientation, the greatest strength of the Tsunami waves was in an East-West direction. Thus, Bangladesh which lies at the northern end of the Bay of Bengal had fewer casualties despite being a low lying country reasonably close to the epicenter. It also aided by the fact that the earthquake progressed more slowly in the northern rupture zone, thereby greatly reducing the energy of the water displacements in that region.

6.13 Maximum height of the waves that struck some of the Indonesian Coastline that have a landmass between them and the Tsunami's location of origin were within safe

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[76] *Paris R.; Lavigne F.; Wassimer P.; Sartohadi J. (2007). "Coastal sedimentation associated with the December 26, 2004 tsunami in Lhoknga, west Banda Aceh (Sumatra, Indonesia)". Marine Geology.*

[77] *Pearce, Fred Holmes, Bob (15 January 2005). "Tsunami: The impact will last for decades". Published by New Scientist.*

limits; as Tsunami waves can sometimes deflect around such landmasses. Thus, Kerala state was hit by the Tsunami even though it was on the western coast of India and similarly, the western coast of Sri Lanka too suffered substantial impacts. Distance alone was no assurance of safety, as Somalia, which was about 4500 km west of the epicenter was hit harder than Bangladesh despite being much farther away. Because of the distances involved, the 2004 Tsunami took anywhere from fifteen minutes to seven hours to reach the coastlines of various countries. The northern regions of the Indonesian island of Sumatra[78] were the first one to be hit quickly, while Sri Lanka and the east coast of India were hit roughly 90 minutes to two hours later. Thailand, despite being closer to the epicenter, was struck about two hours later as the Tsunami traversed more slowly in the shallow Andaman Sea off its western coast.

Fig 6.1

Countries Affected by the 2004 Indian Ocean Earthquake[79]

[78] *"Tsunami time travel map". Tsunami Laboratory, Novosibirsk, Russia. 03 April 2012.*
[79] *http://www.bom.gov.au/tsunami/info/index.shtml*

Early Signs, Warnings & Aftereffects

6.14 Despite a delay of up to several hours between the earthquake and the impact of the Tsunami, nearly all of the victims were taken by surprise, as there were no Tsunami warning systems in the Indian Ocean either to detect Tsunamis or warn the population living around the ocean. Tsunami detection is not simple because while a Tsunami is in deep water, it has little height and to detect the occurrences a network of sensors are required. Installing effective communications infrastructure for early warnings of Tsunamis is an even bigger challenge, particularly in a relatively impoverished part of this part of the world.

6.15 Tsunamis are more frequent in the Pacific Ocean than in other oceans because of earthquakes in the **"Ring of Fire"**[80] (it is a ring of volcanoes around the Pacific Ocean, where most of the earth's volcanoes are located). Though, extreme western edge of the Ring of Fire extends into the Indian Ocean (which was the point where the earthquake struck in 2004). There was no Tsunami early warning systems were in place in that area of the ocean as Tsunamis in that region are relatively rare despite earthquakes being relatively frequent in Indonesia. The last major Tsunami occurred due to 1883 eruption of Krakatoa in Indonesia (the latest being in 2018, which was mild to trigger any Tsunami). Not every earthquake produces large Tsunamis: on 28 March 2005, a magnitude 8.7 earthquake hit roughly in the same area of the Indian Ocean but did not result in to any major Tsunami.

6.16 The ***first warning*** sign of a possible Tsunami is the earthquake itself. However, Tsunamis can strike thousands of kilometers away where the earthquake either could be felt weakly or totally absent Usually, in the minutes preceding a Tsunami, the sea

[80] *Vallée, M. (Published in 2007). "Rupture Properties of the Giant Sumatra Earthquake Imaged by Empirical Green's Function Analysis" . Bulletin of the Seismological Society of America*

often recedes temporarily from the coast, something which was observed on the eastern side of the ruptured zones of the earthquake such as around the coastlines of Aceh province in Indonesia, Phuket Island and Khao Lak area in Thailand, Penang island of Malaysia and some parts of Indian Ocean and the Andaman and Nicobar Islands in India[81]. This unusual sight apparently drawn people, especially children around some of the areas in the Indian Ocean, to visit the coast to investigate and collect stranded fish from as much as 2.5 km off exposed beach, with fatal results when Tsunami suddenly struck.

6.17 The Tsunami arrived along the southeast coast of the Indian mainland in the states of Tamil Nadu and Andhra Pradesh shortly after 9:00 AM. Two hours later, it arrived in the state of Kerala along the southwest coast. Tamil Nadu, Kerala and the union territory of Pondicherry were badly damaged, while Andhra Pradesh escaped with moderate damages. There were two to five tidal waves of varying heights that coincided with the local high tide in some areas during the same time[82]. The Tsunami run-up was only 1.6 m in areas of Tamil Nadu which was shielded by the island of Sri Lanka, but was 4-5 m in coastal districts such as Nagapattinam in the same state as the waves were directly across from Sumatra. On the western coast, the height of the tides was 4.5 m at Kanyakumari District in Tamil Nadu and 3.4 m each at Kollam and Ernakulam Districts of Kerala. The time lag between the waves varied from 15 minutes to 90 minutes. The Tsunami varied in height from 2-10 m as per some of the survivor's description.

6.18 The Tsunami run up height measured in mainland India by Ministry of Home

[81] *Melissa Block on NPR's news dated 27 December 2004, "Sri Lankans Seek Lost Relatives After Tsunami"*
[82] *Jha, M.K. (2010). Natural and Anthropogenic Disasters: Vulnerability, Preparedness and Mitigation. Springer Science & Business Media Publications*

Affairs includes:

(i) 3.4 m at Kerala, inundation distance of 0.5 -1.5 km with 250 km of coastline affected

(ii) 4.5 m at southern coastline of Tamil Nadu, inundation distance of 0.2-2.0 km with 100 km of coast affected

(iii) 5 m at eastern coastline of Tamil Nadu facing Tsunami source, inundation distance of 0.4-1.5 km with 800 km of coastline affected

(iv) 4 m at Pondicherry, inundation distance of 0.2 -2.0 km with 25 km of coast affected

(v) 2.2 m in Andhra Pradesh, inundation distance of 0.2 -1.0 km with 985 km of coast

6.19 The Tsunami travelled 2.5 km off shore at Karaikal in Puducherry. The inundation distance varied between 100 - 500 m in most areas, barring at river mouths, where it was over a kilometer. Areas with dense cover of mangroves or coconut groves had much lesser inundation distances while those with river mouths or backwaters saw larger inundation distances. Existence of seawalls at the Kerala and Tamil Nadu coasts too lessened the impact of the waves. When the seawalls were made up of loose stones or concrete blocks, they however were displaced and carried a few meters inland.

6.20 Three densely populated districts of Kerala state namely Ernakulum, Alappuzha, and Kollam experienced Tsunami related damages, possibly due to diffraction of waves around Sri Lanka Island[83]. The southernmost district of Thiruvananthapuram, however, escaped destruction, possibly due to the wide turn of the diffracted waves at the peninsular tip. Major damages occurred in two tapered strips of land which was one

[83] *Sheth, Alpa (June 2006). "Effects of the December 2004 Indian Ocean Tsunami on the Indian Mainland" Published by Earthquake Spectra http://www.iitk.ac.in/nicee/RP/2006_Effect_EQSpectra.pdf*

on the west by the Arabian Sea and on the east by the Kerala backwaters. The waves receded before the first Tsunami with the highest fatality reported from the densely populated Alappuzha panchayat (including the villages of Cheriya Azhikkal and Azhikkal) at Kollam district caused by a 4m Tsunami. The worst affected area in Tamil Nadu was Nagapattinam district, with 6,051 fatalities reported by a 5 m Tsunami wave, followed by Cuddalore district, where many villages got destroyed. The 13 km Marina Beach in Chennai was battered by the Tsunami which swept across the beach. In Puducherry, a 10 m black muddy Tsunami ravaged the city of Karaikal, where 492 lives were lost. The city of Puducherry which was protected by seawalls was relatively intact.

6.21 Tsunami waves destroyed many villages in Andhra Pradesh. In Krishna district the Tsunami created havoc in Manginapudi and Machalipatanam towns. The most affected was Singraikonda town in Prakasham District recording 35 deaths. Given the enormous destructive power of Tsunami, the fishing industry suffered the maximum. Moreover, the cost of damage in the transport sector was reported in crores. The effects of Tsunami varied greatly across different coastal areas which were directly proportional to the waves experienced, the inundation of distance, height of waves, the population density of the affected area and topographical features. Most of the people killed were members of the fishing community[84].

6.22 One of the most affected States in India was the isles of Andaman & Nicobar. Tsunami arrived in the Andaman and Nicobar Islands minutes after the earthquake causing widespread destruction to the islands' environment. The islands of Little Andaman and the Nicobar were severely affected by the Tsunami. The Tsunami survey

[84] *Sheth, Alpa; et al. (June 2006). "Effects of the December 2004 Indian Ocean Tsunami on the Indian Mainland": Earthquake Spectra*

was carried out in Little Andaman, South Andaman, mainly in and around Port Blair, Car Nicobar along the Kankana-Mus sector, and Great Nicobar archipelago.

6.23 As per local eyewitnesses, there were three Tsunami waves in South Andaman. Of the three, the third wave was the most devastating. Flooding occurred along the coastlines of the islands and low lying areas inland, connected to open sea through creeks. Inundation was observed all along east coast of South Andaman Island, which are primarily in and around Port Blair township and limited to Burmanallah, Chidiyatapu, Kodiaghat, Beadnabad, Corbyn's cove and Marina Park/Aberdeen Jetty areas. Along the west coast of Port Blair, the inundation was mainly observed around Guptapara, Manjeri, Wandoor, Collinpur and Tirur regions. Many shore establishments and numerous infrastructures such seawalls and a 20 MW diesel generated power plant at Bamboo Flat were extensively damaged[i].

6.24 Results of the Tsunami survey in South Andaman along Chiriyatapu, Corbyn's Cove and Wandoor beaches are as follows:-

(i) 5.0 m in maximum Tsunami height with a run-up of 4.24 m at Chiriyatapu Beach.

(ii) 5.5 m in maximum Tsunami height and run-up at Corbyn's Cove Beach.

(iii) 6.6 m in maximum Tsunami height and run-up of 4.63 m at Wandoor Beach.

6.25 At Port Blair the water receded before the first wave, and the third wave was the tallest and caused the most damage. However, at Hut Bay, Car Nicobar and Campbell Bay locations south of Port Blair, the water level rose by about 1 to 2 mtr from the normal sea level before the first wave crashed ashore[85]. Reports of Tsunami

[85] *T. Ghosh, P. Jana, T.S. Giritharan, S. Bardhan, S.R. Basir, A.K. Ghosh Roy. (2007). Tsunami survey in*

wave height in Andaman were as follows:-

(i) 1.5 m at Diglipur and Rangat at North Andaman Island

(ii) 8 m high at Campbell Bay on Great Nicobar Island

(iii) 10-12 m high at Car Nicobar Island and at Hut Bay on Little Andaman Island

(iv) 3 m high at Port Blair on South Andaman Island

6.26 The significant shielding of Port Blair and Campbell Bay were because of the steep mountainous and bay areas all around. This significantly contributed to the relatively low wave heights at these locations, whereas the open terrain along the eastern coast at Car Nicobar and Hut Bay contributed to the great height of the Tsunami waves.

6.27 In the Little Andaman, Tsunami waves impinged on the eastern shore of this island 25 to 30 minutes after the earthquake in a four-wave cycle of which the fourth one was most destructive with a wave height of about 10 m. The Tsunami waves destroyed settlements at Hut Bay within a range of 1 km from the seashore. Run up level up to 3.3 m have been measured. In the island of Car Nicobar, there were three Tsunami waves. The first wave came within 5 minutes after the earthquake, preceded by retrieval of the seawater up to 600 - 700 m. The second and third waves came at 10 minutes intervals each after the first wave. The third wave was the strongest, with a maximum height of 11 m. Waves nearly 3 stories high devastated the entire Indian Air Force base, located just south of Malacca strait on Carnic Island. The maximum height of the Tsunami wave was 11 m and ingress of sea waters was found to be up to 1.25 km inland. 5 m tidal waves were also inundated 2.5 km inside the

Carnic Township sweeping many hamlets enroute. The impact of the waves was so severe that four Oil tankers of IOC were thrown almost 800 m from the seashore off the Air Force colony main gate. Double storied residential buildings were found completely submerged under the seawater killing almost all the inmates of those buildings. In Chuckchucha and Lapati towns, the Tsunami struck in a three wave cycle with a maximum wave height of 12 m[86].

6.28 In Campbell Bay of Great Nicobar Island, the Tsunami waves hit the area three times with an inundation surge of 250 - 550 m. The first wave came within 5 minutes of the earthquake. The second and third waves followed 10-minute intervals after the first one. The second wave was the strongest. Lethal Tsunami waves inflicted havoc in this heavily populated Jogindar Nagar area, situated 13 km south of Campbell Bay. According to local sources, Tsunami waves struck the area three times. The first wave came within 5 minutes after the main shock (at 0629 hrs.) with a marginal drop in sea level. This was followed by a second wave 10 minutes later with a maximum height of 4.8 m. The third wave came after 15 minutes of the second with a lower wave height. The maximum inundation of Tsunami waters was about 500 m in to the mainland. The second wave caused the maximum destruction.[87]. The maximum affected island in the Andaman & Nicobar chain of islands was Katchall Island with 303 people confirmed dead and 4,354 missing out of a total population of 5,312[88].

Effect of Tsunami on India

6.29 India was the third country that was severely affected, after Indonesia and

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[86] *T. Ghosh, P. Jana, T.S. Giritharan, S. Bardhan, S.R. Basir, A.K. Ghosh Roy. (2007). Tsunami survey in Andaman and Nicobar group of Islands. Geological Survey of India Special Publication no. 89. 165–184*

[87] *T. Ghosh, P. Jana, T.S. Giritharan, S. Bardhan, S.R. Basir, A.K. Ghosh Roy. (2007). Tsunami survey in Andaman and Nicobar group of Islands. Geological Survey of India Special Publication no. 89. 165–184*

[88] *Paul, D.K.; Singh, Yogendra; Dubey, R.N. "Damage to Andaman & Nicobar Islands due to Earthquake and Tsunami of Dec. 26, 2004". Department of Earthquake Engineering, IIT Roorkee*

Sri Lanka. The official death toll in India was reported be 10,749 and another 6000 people were reported missing or feared to be dead. Approximately 1,54,000 homes were destroyed and 600,000 people were displaced and rendered homeless. The overall financial loss to India was estimated at about $ 2 billion US dollars. The fishermen communities that lived along coastline suffered the most damage and destruction. Nearly 80 percent of the dead on the mainland were from the fishing communities. They lost their homes, boats and their source of livelihood[89].

6.30 **Affected States and Regions.** This disaster affected a total of fourteen regions in India both affecting the Andaman archipelago as well as the coastal regions of main land India. The Andaman and Nicobar Islands comprise of more than 550 islands of which only 38 are inhabited by people mainly from the mainland India and native indigenous tribes. Many of the islands were just north of the earthquake epicenter where Tsunami waves reached to a height of 15 meters in the Southern Nicobar Islands. As per the official data, total death toll was 1,310, with about 5,600 missing. Unofficially, the death toll, including those missing and presumed dead was estimated at about 7,000. This ocean earthquake coupled with Tsunami goes down in history as the deadliest of all time. It took the lives of over 230,000 victims and wounded more than double this number across the globe. The Great Nicobar and Car Nicobar islands were the worst hit among all the islands of Andaman's they were exposed to the quake because its flat terrain. Aftershocks continued to haunt the islands for days, and one-fifth of the population of the Nicobar Islands was reported dead,

[89] *Excerpts from case studies by Oxfam-America and Prof. Revathi I. Hines, Training workshop on gender and DRM – UNDP Pacific Centre – January 2010*

injured or missing. Two-thirds of Chowra Island's population comprising of 1,500 perished. While this entire Island was marooned, the Trinket Island was divided in two. Communications were cut off to the Nancowry group of islands, some of which were inundated under water for weeks.

6.31 In Car Nicobar, 111 Indian Air Force personnel and their family members were washed away when the Tsunami severely damaged their air base. Many religious structures and sports facilities were washed away. Entire Car Nicobar Island tilted by couple of degrees to north while the sea has ingressed at least 100 meters towards the shore line.

6.32 Most of the populations of the Andaman Islands are the people from the mainland India, primarily from West Bengal, Jharkhund, Andhra Pradesh and Tamil Nadu. The natives of the Andaman and Nicobar Islands are endangered and protected tribal groups, such as the Jarawa, Sentinelese, Shompen, Onge, Nicobarese and the Great Andamanese. They are anthropologically significant as some of these are the world's most primitive tribes. Many of these tribes have maintained their own culture and lifestyles for centuries. Government policy too is one of non-interference. Nearly all the native islanders reportedly survived the Tsunami since they lived on higher grounds or far from the coast. The Onge (population of 101 as per 2011 census), Jarawa (380 as per 2011 census), Sentinelese (100 to 200 people, estimated as per 2010 census) and Great Andamanese (52 as per 2010 census) were reached by survey teams. The Sentinelese tribe, from a prohibited island reserve, is hostile to strangers and often attacked the surveyors. On the Nicobar Islands; the Nicobarese, a tribe with a Southeast Asian heritage (2001 population 28,653), lost about 656 people with 3,000 missing. Surprisingly, Shompen tribe (2001 census count of 398) located on

Great Nicobar Island and nearly all of the Onge tribal community survived the wrath of Tsunami[90].

6.33 Barren Island (which is 135 km northeast of Port Blair) and India's only active volcano erupted on 30 December 2003 due to increased seismic activity. The southernmost part of India Indira Point in Great Nicobar Island which had tidal waves rising 4.25 meters left some ships of coastguard and local fishing boats along with its only lighthouse damaged.

6.34 The tsunami waves struck the mainland with a height ranging from 3m to 10 meters and penetrated 300 m to 3 km inland, affecting approximately 2,260 km of coastline with varying intensity. As per the joint report prepared by Asian Development Bank, United Nations and World Bank New Delhi, India March 8, 2005[91], the largest number of villages impacted were in Tamil Nadu (376), followed by Andhra Pradesh (301), Kerala (187) and Pondicherry (33). Tsunami shattered communities with its high toll of human lives, injuries, livestock, homes, family networks and livelihoods. There were long term repercussions for families torn by death or disabilities of members, leaving many widows, children, orphans, and children separated from their families, the elderly and the disabled traumatized. Majority of those affected on the coast were fisher folk who suffered the most damage in terms of housing and livelihoods with losses to their dwelling units, household assets, and their only lively means boats and nets[92].

6.35 **Economic Impact.** The extent of damage to the economy resulting from the

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[90] *"National: All primitive tribes safe". The Hindu. 31 December 2004*

[91] *India Post Tsunami Recovery Program Preliminary Damage and Needs Assessment Prepared by Asian Development Bank United Nations and World Bank New Delhi, India March 8, 2005 paraB2 Pp 30*

[92] *India: 'Status of Life in Temporary Shelters' REPORT from Swayam Shikshan Prayog Published by reliefweb on 17 Jul 2005*

Tsunami depends on the scale examined. While local economies were devastated, the overall impact to the India's economy was minor because of the huge GDP. The two main activities affected by the Tsunami were fishing and tourism. The impact on coastal fishing communities and the people living there, some of the poorest in the region, had been devastating with huge losses to income earners as well as to boats and fishing equipment. In addition to this, many ports, roads and railway lines, electrical & power lines and communication lines too were damaged beyond repair. In Andaman, especially in Port Blair many Indian Naval and Coastguard ships along with intra island passenger liners were damaged.

6.36 **Environmental Impact.** In addition to the heavy causalities of human lives and livestock, the Tsunami of 2004 has caused an enormous impact on the environment that will continue to affect the region for many generations to come by. Extensive damage were also inflicted on ecosystems such as Coral Reefs, Mangroves, Forests, Coastal Wetlands, Vegetation, Rock Formations, Animal and Plant Biodiversity and Groundwater/fresh water wells. According to specialists, the main effect is being caused by contamination to the freshwater supplies, soil salination by the ingress of saltwater infiltration and deposit of a salt layers over arable land. It has been reported that in the Andaman alone, 16 to 17 major coral reefs that were asphyxiated by sea waves could be rendered uninhabitable for decades. Large tracts of corals have died, affecting the aquamarine culture, coastal and marine ecosystem of the Andaman ocean region. Innumerable fresh water wells that served communities were swamped by sea water, sand, and earth; and aquifers were invaded through porous rock. Soil became sterile due salt deposits which would render difficultly and costly to

restore for agriculture purposes[93]. It also caused death to plants, many micro-living organs and important soil micro-organisms. Thousands of rice, mango, and banana plantations in coastal areas of Andhra and Tamil Nadu were destroyed almost entirely and had taken years to recuperate. There had been some terrestrial and aquatic pollution too, both in terms of physical debris as well as sewage and chemical effluents. Pollution was more problematic on land and in closed systems such as lagoons; ponds and streams adjoin the coastal areas[94].

6.37 **Other Effects.** Many health professionals and aid workers have reported widespread psychological and emotional trauma associated with the tsunami in most of the affected areas, medical emergencies could not be provided due to the collapse of the medical infrastructure. Rehabilitation process, especially in Andaman, has taken years to take its effect due to the distance from the main land. In fact the process is still on, in spite of so many years elapsed.

6.38 **Post Tsunami Rehabilitation & Restoration Process.** Though the GoI and the State Governments of Tamil Nadu, Kerala, Andhra Pradesh and the Pondicherry Administration were caught off guard by the Tsunami still they acted swiftly with prompt and timely actions. The Indian Government along with state Governments has promptly indulged themselves in the rehabilitation & restoration process, post tsunami. Immediately after the disaster, displaced people moved to relief camps provided by the government and NGOs. In the various affected states and union territories the respective Chief Ministers directed officials of the Revenue Department under the Relief Commissioner to coordinate search, rescue and relief efforts through relevant

[93] *Helping restore the quality of drinking water after the tsunami. International Water Management Institute, 2010. Downloaded 25 February 2011)*

[94] *"Impact of Tsunamis on Ecosystems". United Nations Atlas of the Oceans. 10 March 2005*

district collectors with assistance from the police force, fire and rescue services, medical and health services and all other associated departments. Indian Armed Forces, Indian Coastguard, NGO / Civil societies, Private sector, International Community, especially, the United Nations Disaster Management Team designated the United Nations Children's Fund (UNICEF) as the focal point for relief activities. UNICEF deployed rapid action teams and sent reports within 72 hours of the disaster. Various other UN organisations supported UNICEF to carry out relief activities. Additionally, the UNDP has helped to coordinate UN agencies efforts in terms of rehabilitation and recovery. Other UN agencies that were involved in the recovery process include the International Labor Organization, United Nations Industrial Development Organization, Food and Agriculture Organization, World Health Organization, UNICEF, United Nations Population Fund and United Nations Education Social & Cultural Organization. A UN Team for Recovery Support was also established in Chennai. Financial relief in terms of Ex Gratia payments too were paid to the affected people by various Governments along with generous donations by the citizen of our country as well as international communities.

***Ex Gratia* Payments[95]**

Government	***Ex gratia***
Government of India	The Prime Minister announced an ex-gratia payment of Rs. 100,000 to the next of kin of each deceased. The payment will be made from the Prime Minister's National Relief Fund.

[95] *Project Report prepared by Asian Development Bank, United Nations and World Bank New Delhi, India dated March 8, 2005*

Govt of Tamil Nadu	The Chief Minister announced an ex-gratia payment of Rs. 100,000 to the family of each victim.
Govt of Kerala	*Ex gratia* payment of Rs.50,000 to the next kin of those killed; assistance of Rs.10,000 to the families of the deceased to meet funeral expenses
UT of Puducherry	Chief Minister N. Rangasamy announced an *ex gratia* payment of Rs 100,000 (one lakh) to the next of kin of those killed. The administration would also pay an *ex gratia* Rs5000 towards funeral expenses. For those injured in the disaster, the administration would provide Rs5000. A sum of Rs10,000 would enable the homeless to rebuild their homes.

Table 6.1

BHUJ EARTHQUAKE: 26 JANUARY 2001

6.39 A Powerful Earthquake of magnitude 7.7Mw on Richter-Scale rocked the Western Indian State of Gujarat on the 26th of January, 2001. It caused extensive damage to life & property. This earthquake was so powerful in its magnitude that left thousands dead, or seriously injured, bruised and handicapped; battered them physically, psychologically and economically. The epicenter of the quake was located at 23.6 North Latitude and 69.8 East Longitude, which was about *20 km Northeast of Bhuj Town* of the Kutch district in Western Gujarat[96]. At a depth of only 23 kms below surface, yet this quake generated intense vibrations and tremors that were felt around 70% region of India and far beyond its neighboring Pakistan and Nepal too. The aftershocks continued to batter the Kutch area for weeks causing extreme anxiety to a large population of this area. Historically, Seismic activity was prevalent in the

[96] *Ref: OCHA/GVA - 2001/0016 UN Office for the Coordination of Humanitarian Affairs Situation Report No. 2 India – Earthquake published on 26 January 2001*

affected Area of Kutch. This region falls in Seismic Zone V, the only such zone outside the Himalayan Seismic Belt. The earthquake of this magnitude was not experienced in the last 50 years[97].

6.40 21 of the total 25 districts, 18 towns, 182 talukas and 7904 villages of Gujarat state were affected in this quake. Many of the affected areas even spread up to 300 km from the epicenter. Four major urban areas In the Kutch District namely, Bhuj, Anjar, Bachau and Rapar suffered extensive destruction. Over 450 villages in rural Gujarat were also very badly affected; most of them were totally destroyed.

6.41 In addition, wide spread damages also occurred in Rajkot, Jamnagar, Surendranagar, Patan and Ahmedabad districts. Many Urban areas such as Gandhidham, Morbi (Ceramic industry), Rajkot and Jamnagar have also suffered heavy damage to major structures, infrastructure and industrial facilities. Ahmedabad the capital was also severely affected. Anything between 13,805 and 20,023 causalities' was reported with another 167,000 injured and destroyed nearly 400,000 homes[98].

Number of Affected Villages and Talukas[99]

Sl No	Name of District	No.Of Affected Talukas	No.Of Affected Villages	Population Affected
01	Ahmedabad	11	484	5,461,178
02	Amreli	11	273	864,626
03	Anand	8	112	468,725
04	Banaskantha	9	320	88,826

[97] *Rabindra, Vasavada; Edmund, Booth (2001). "Effect of the Bhuj, India earthquake of 26 January 2001 on heritage buildings".*

[98] *"Preliminary Earthquake Report". S. Geological Survey Earthquake Hazards Program, U, National Earthquake Information Center World Data Center for Seismology, Denver 2001*

[99] *The Kutch Earthquake 2001 Recollections, Lessons and Insights Auth Pramod K. Mishra Published by National Institute of Disaster Management(Ministry of Home Affairs, Govt. of India) Pp 76*

05	Bharuch	8	270	822,572
06	Bhavnagar	11	377	1,685,378
07	Gandhinagar	4	210	916,522
08	Jamnagar	11	685	1,902,680
09	Junagadh	13	554	1,876,736
10	Kheda	9	404	1,231,273
11	Kutch	10	890	1,523,562
12	Mehsana	9	611	1,818,445
13	Navsari	5	313	1,104,473
14	Patan	8	349	764,645
15	Porbandar	3	157	494,605
16	Rajkot	14	686	2,496,279
17	Sabarkantha	8	68	150,641
18	Surat	8	94	1,483,518
19	Surendaranagar	10	659	1,512,189
20	Vadodara	6	85	205,648
21	Valsad	5	32	368,017
	Total	181	7633	28,039,538

6.42 Gujarat earthquake of 2001, presented many opportunities to draw lessons, which ultimately helped in formulating forward looking policies pertaining to disaster management in the whole of country, especially related to earthquakes. Gujarat Earthquake became the source to the earthquake disaster mitigation policies in India. The problems pertaining to the earthquakes are similar the world over. The issues in the recovery and reconstruction phase are very important for the proper understanding risk management among various stakeholders, training and confidence building among the professionals with appropriate developmental planning strategies. This quake has provided numerous illustrations and takeaways in geo-technical and structural failures. The traditional design and construction practices of buildings in the country came under criticism for the first time. It has triggered broad understanding on what needs to be done in this sector.

Tectonic Setting

6.43 Kutch area falls in Seismic Zone V. This is the only such zone outside the Himalayan Seismic Belt. Though, Gujarat lies 300 to 400 km away from the plate boundary between the Indian Plate and the Eurasian Plate, but the current tectonics continued to be governed by the effects of the continental collision along this boundaries. As a result of the collision with Eurasia, the entire area has undergone shortening, encompassing both reactivation of the original rift faults and development of new low-angle thrust faults[100].

6.44 The related folding has formed a series of ranges, particularly in central Kutch. The mechanism of most earthquakes is consistent with reverse faulting on reactivated rift faults. The pattern of uplift and subsidence associated with the 1819 Rann of Kutch earthquake is consistent with reactivation of such a fault[101] [102]. The 2001 Gujarat earthquake was caused by movement on a previously unknown south-dipping fault, trending parallel to the inferred rift structures[103].

Effects

6.45 The death toll in the Kutch region was 12,300. Bhuj, the major town of Kutch was located 20 Kilometers from the epicenter was completely devastated. Substantial

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[100] *Vol. 8 (4) Land use land cover changes in pre- and post- earthquake affected area using Geoinformatics – Western Coast of Gujarat, India Guru Balamurugan* and Sridhara Aravind M. Geoinformatics Laboratory, Tata Institute of Social Sciences, Mumbai – 400088, India dated April - 2015*

[101] *Bodin, P.; Horton S. (2004). "Source Parameters and Tectonic Implications of Aftershocks of the Mw 7.6 Bhuj Earthquake of 26 January 2001" (PDF). Bulletin of the Seismological Society of America. Seismological Society of America. Pp **94** (3): 818–827.*

[102] *Li, Qingsong; Liu, Mian; Yang, Youqing (17 March 2013). "The 01/26/2001 Bhuj, India, Earthquake: Intraplate or Interplate?". Plate Boundary Zones. Geodynamics Series. American Geophysical Union. pp. 255–264*

[103] *Maurya, D. M.; Chowksey, Vikas; Patidar, A. K.; Chamyal, L. S. (2017). "A review and new data on neotectonic evolution of active faults in the Kachchh Basin, Western India: legacy of post-Deccan Trap tectonic inversion". Geological Society, London, Special Publications*

damage also occurred to the towns of Bhachau and Anjar with hundreds of peripheral villages razed in many Talukas of Anjar, Bhuj and Bhachau. Lakhs of structures were damaged or destroyed, including many historical, heritage buildings of tourist attractions. The quake destroyed around 40% of homes, eight schools, two hospitals and 4 km of roads in Bhuj.

6.46 Ahmedabad, with a population of nearly 7 million saw about 50 multi-storied buildings getting collapsed and several hundred people getting killed. The earthquake destroyed about 60% of food and water supplies In Kutch. Around 258,000 houses and 90% of the district's houses were either destroyed or damaged rendering irreparable. The biggest setback was the total destruction of the Bhuj Civil hospital and the Air Force Station. The Indian Military Medical teams were air lifted immediately and provided emergency support and first aid care, which was later augmented by the International Federation of Red Cross, Red Crescent Society and an Israeli field hospital staff. A temporary Red Cross hospital and Israeli field hospital remained in Bhuj for some time to provide medical care while a replacement hospital was built subsequently[104].

6.47 **Infrastructural Damages.** 20 railway stations across Kutch region were damaged with Gandhidham Stn suffering the worst. Railway tracks too were damaged at many places. Many of them were bent or fish plates were uprooted. However, no major damages were observed to the Railway bridges. Most of roadways, including many places on NH 8A were found cracked or bulged. Many culverts and embankments have caved in leading to major disruption to the traffic. Most of the minor roadway and highway bridges and their parapets in this region were

[104] *Eidinger, John M. (2001). Gujarat (Kutch), India, M7.7 Earthquake of January 26, 2001, and Napa M5.2 Earthquake of September 3, 2000. ASCE Publications.*

considerably damaged. The damage to the structures the major ports viz., Kandla, Navlakhi and Adani were negligible. By and large, docking berths, pylons and Over-head gantries escaped the wrath of the earthquake.

6.48 The 370 MW coal-lignite thermal plant located in Panandhro, 180 km northwest of the epicenter had experienced minimal damage, similarly, while there was no damage to a coal-burning plant in Ahmedabad. The operational Kakrapar nuclear power plants Unit No.1 (220MW) and No.2 located 400km southeast of the epicenters was also safe, thereby ensuring uninterrupted power supply to the affected region.

6.49 In the Anjar 220 KV substation, the communications system and power protection system facilities collapsed. Most of the transformers destroyed and so are the telephone lines/cables. Most of the damage to these installations was observed in the areas adjoining the epicenter area, particularly Bachau, Anjar, Lilpar, Chobari, Ratnal and the old city of Bhuj.

6.50 Many modern RCC multi-storied buildings collapsed in the two densely populated cities of Ahmedabad and Gandhidham. Many other towns too felt the brunt of earthquake viz., Jamnagar, Rajkot, Gandhinagar, Morbi etc. Hundreds of buildings suffered irreparable damages to their structures. As per IIT Kanpur report, houses which were constructed with lime mortar remained relatively undamaged.

First Response

6.51 The response to a system or organization depends significantly on how the people concerned respond to a situation. Bhuj earthquake was an excellent example of this. As soon as the news broke out, the entire state Disaster Management machinery was activated. The State Emergency Control Room at Gandhinager was activated by 0930hrs. The Collectors of Sabarkantha, Patan, Rajkot, Jamnager districts gave the first

hand information on the death toll and other damage in their respective areas. Districts such as Sabarkantha, Panchmahals, Mehsana, Gandhinagar, Kheda and Anand were each asked to send 50 truckloads of firewood and 50-60 water tankers to the affected districts. Mother Dairy and Amul Dairy were requested to supply milk by the Commissioner of Relief and Principal Secretary and Revenue, Gujarat. Within an hour after the earthquake, the entire telecommunication system in the Gandhinagar and Ahmedabad area broke down. In addition to the complete breakdown of the landline telephone system, cellular networks also collapsed. Communication, even between Gandhinagar and Ahmedabad, became impossible. The satellite telephone in the state control room the Air Force Communication lines were used to try and contact Bhuj. Preliminary communication between the state control room and Bhuj indicated that the situation was alarming in Kutch. By 11.30 a.m., it was confirmed that the Bhuj area had been completely devastated by the earthquake. Information also trickled in from sources other than the official channels like the Army and Air Force communication networks. The South Western Air Command and Army Division at Gandhinagar and Ahmedabad immediately were alerted and their search and rescue machinery were activated at once. Helicopters from Jamnagar and transport aircraft from Ahmedabad and Vadodara were immediately dispatched with medical teams and relief material.

6.52 The Military Hospital along with the Air Force Medical center were the only functioning medical facilities in the vicinity (as the Government General Hospital, a 281-bed facility, at Bhuj was completely destroyed), which was soon overwhelmed by the deluge of dead, dying and injured persons. By 11 a.m., a few enterprising private doctors started treating the injured and initiated medical relief activities at an open ground which later became famous as Hospital Ground. In spite of having only a

temporary hut, the doctors present there continued their best efforts with whatever little equipment and medical supplies that were available. Military doctors too started treating the injured from makeshift tents from the airfield itself as hordes of injured started arriving by the Indian Air Force and Army Helicopters to Bhuj. The district administration also concentrated its efforts to provide medical supplies. Emergency medical stores were released and supplies were diverted to these makeshift Medicare centers by the district authorities.

6.53 Search and rescue operations need a large number of equipment such as bulldozers, cranes, and concrete cutters. All out efforts were made by everyone, be it the Armed Forces, NGOs, Dist officials, businessmen or farmers to mobilize such equipment from any sources that were available. Sincere efforts were made by the State agencies to carry out rescue operations with whatever resources that was available. Efforts were also made to ensure other tasks such as provision of food, medical services, transportation, electricity and temporary shelters. Medical teams that started reaching Bhuj were deployed at various places. By the third day, rescue and medical teams from various countries and international organizations started arriving. They were very well equipped and self-sufficient. Medical teams from France, Japan, Norway, Finland and Korea and along with Israel Army & Air Force teams. They were complimented by the Indian relief teams from the Indian Army who came with their own search and rescue teams and rehab material. All the teams promptly supported the local teams in providing timely search and rescue, medical and rehab aid.

6.54 The National Crisis Management Committee convened the meeting and deliberated on the situation at 1500 hrs in Delhi. In the meantime, the Cabinet Secretary had already interacted with several state secretaries, asking them to mobilize

maximum possible resources. The cabinet secretary along with 30 doctors from the All India Institute of Medical Sciences and Safdarjung Hospital reached Bhuj around 8.30 pm to provide relief and emergency Medicare.

6.55 Even after two days, communication continues to be a grey area. Damage to the Surajbari Bridge disrupted road movement. VHF and HF wireless facilities were activated along with Satellite communication were brought in to restore temporary communication facilities with state secretariat. However, the Bhuj Air Force Station runway, in spite of some damage, remained functional. This facilitated the movement of supplies from various parts of the country and abroad. Another important issue was the acute shortage of wood required for cremation in Bhuj and other affected areas. At many places one could see volunteers cremating dead bodies after extricating them from the debris. The scene was no different at many places such as Bhachau, Anjar and Rapar. Hospitals were increasingly becoming overcrowded and cremation grounds were working 24X7.

6.56 **Role of the Armed Forces.** Army personnel stationed at Bhuj and Gandhidham quickly geared up to provide assistance to the civilian population. Within 45 minutes of the disaster, the two army units sent out 14 and six columns respectively for relief operations. On the first day itself, the army rescued 110 people and recovered 116 dead bodies at Bhuj. Likewise, they rescued 108 people and recovered 58 dead bodies from Gandhidham. The military hospital, being the only well-equipped hospital in Bhuj and adjoining areas, treated thousands of civilians. The GOC-in-C, Southern Command flew in from Pune along with four surgical units. Having assessed the situation, additional medical personnel, equipment and infantry units were moved to Kutch for providing relief. The army restored arterial road communications of major

towns and villages. AOC-in-C SWAC, quickly ordered airlift of rehabilitation material, medicines, surgical equipment besides water and food for the affected people from every Air Force Station under his jurisdiction. Specialists from various units were augmented. Security of relief material poured in various parts of the world was ensured at Air Force Stn Bhuj. The Armed Forces also organized large-scale rescue efforts, including eight engineering regiments, 36 columns, 48 IAF aircrafts/helicopters and 953 sorties[105]. More than 5,000 trucks, bulldozers, cranes and gas cutters etc., were organized for the rescue efforts. The Air Force pressed into service six IL-76, 18 AN-32, four Avros, four Dornier airplanes and 16 helicopters. They flew nearly 1000 sorties, carrying relief materials, tents, equipment, food items, rescue teams and injured persons. The army deployed a large number of troops in the Bhuj and Ahmedabad sectors. In addition, three columns of the 68 Engineers Regiment were deployed for technical inspection of buildings that were rendered unsafe. A large number of vehicles and equipment were also deployed. They rescued 478 persons, evacuated 484 seriously injured persons and recovered 2,260 dead bodies. The Indian Navy dispatched a team of 30 men with INMARSAT satellite phones. The INS Ganga carried relief materials to Kandla and two naval ships were converted into hospital ships where surgeries were performed. A Dornier operated between Mumbai and Kandla carrying fresh water.

6.57 The Union Home Ministry released a number of companies of the Central Paramilitary Forces for rescue and relief work. Initially 47 of these, such as the RAF, CRPF and BSF, provided rescue and relief services. A number of ministries such as Chemicals and Petrochemicals, External Affairs, Finance, Food and Public

[105] *Recollections, Lessons and Insights. auth Pramod K. Mishra Pp-43 Pub NDMA, MHA, GoI, Pp66*

Distribution, Mines, Health, Petroleum, Railways, Shipping, Power, Social Justice and Empowerment, Rural Housing, Telecommunication, Urban Development and Women & Child Development participated in providing immediate relief.

6.58 The Ministry of Railways deployed special trains with relief materials from Mumbai, Madras, Kolkata and New Delhi to Ahmedabad and Bhuj. Ministry of Power arranged for generator sets for utilization by the GEB in the Kutch district. The Powergrid Corporation and the National Thermal Power Corporation assisted in repairing and re-commissioning of 10 sub-stations of the GEB. The Power Finance Corporation sanctioned a loan of Rs 100 crores for the repair and reconstruction of transmission and distribution systems. The Rural Electrification Corporation also sanctioned a loan of Rs 100 crores. Many State Governments spontaneously offered relief assistance, both in cash and kind, including Andhra Pradesh (unified), Assam, Bihar, Chhattisgarh, Delhi, Dadra and Nagar Haveli, Goa, Himachal Pradesh, Haryana, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Orissa, Punjab, Pondicherry, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, Uttaranchal, and West Bengal. Food, blankets, medicines, medical personnel, water tankers, water bottles, daily essentials, equipment etc., were sent by various state governments and union territories. Many of them also contributed to the Gujarat Chief Minister's Relief Fund. Some of these states sent not only equipment and material but also senior officials and supporting staff to undertake relief work. Few of them participated in the reconstruction and rehabilitation work also.

6.59 **Assistance by the Domestic and International Communities.** As a policy, the GoI did not appeal for any international humanitarian assistance. However, looking at the magnitude of the disaster, departing from the earlier practices, assistance offered

was accepted from the international communities. The United Nations Disaster Assessment and Coordination (UNDAC) team visited the earthquake-affected areas as advised by the Office of the Coordination of Humanitarian Affairs (OCHA) on 27 January 2001, in consultation with the Government of India, to assist the Indian authorities and the UN with the coordination of international assistance. The UNDAC team established an On-Site Operations and Coordination Center (OSOCC) at Bhuj to facilitate coordination of all relief activities under one umbrella. The OSOCC was located within the premises of the office of the Kutch Collector. It became the nodal point for international coordination and for information sharing, both for government officials and NGOs. USAID was again a great help to the people of Kutch helping them with their generous grants both in kind as well as cash in the rehabilitation process. A report of 20 February 2001 prepared by the UNDAC team provides the under mentioned details:

(i) Search and rescue teams from abroad began their operation at 2300 hours on 27 January, when the Swiss search and rescue team arrived by air, closely followed by teams from the UK, Russia and Turkey. The Swiss rescue team consisted of 52 members and 12 sniffer dogs. As soon as they arrived in Ahmedabad they immediately proceeded to the site of the nearest multi-storied building in Ahmedabad and started their rescue efforts. They rescued eight people during their operation.

(ii) There were two teams from the UK and their search and rescue team comprised of 69 people with equipment. They rescued six survivors and recovered two dead bodies. The British International SAR and dog team had eight members, one dog and sundry equipment.

(iii) A total of 26 international teams arrived in Gujarat by 02 February (***below depicted table refers***). The first teams started arriving by 27th Jan and by 15 February almost all had left. As there was no possibility of rescuing more survivors by then, the remaining teams were deployed on more general relief tasks, some helping with the recovery of bodies, others with debris clearance, relief and medical support and few provided assistance to the local teams. The Indian Air Force in consultation with MoD was magnanimous in giving the Air Ops clearances to the international military and civil aircrafts without any delay.

INTERNATIONAL SEARCH AND RESCUE, AND MEDICAL TEAMS IN KUTCH[106]

Country	Manpower
Bulgaria	137 Persons and Trauma Kits
Denmark	Medical Team
France	32 Persons, 9 Dogs and Equipment
Germany	30 Persons and 6 Dogs
Hungary	52 Persons and 1 Dog
Israel	100 Persons and Equipment
Italy / Spain	11 Persons and 10 Dogs
Japan	58 Persons
Mexico	6 Persons including 1 Doctor and Paramedics
Netherlands	Doctors with Medical Equipment
Poland	15 Persons including 10 Firemen and 2 Doctors
Russia	76 Persons and Equipment

[106] *Report of UNDAC Team and Government of Gujarat (Revenue Department) Presentation*

South Africa	31 Persons, 2 Dogs and Equipment
South Korea	36 Persons (including 23 Doctors) and Medical Supplies
Switzerland	52 Persons and 12 Dogs
Turkey	27 Persons and Equipment
USA	10 Persons
UK	75 Persons, 1 Dog and Equipment
Ukraine	Team with Mobile Hospital

Table 6.2

Source: Report of UNDAC Team and Government of Gujarat (Revenue Department)

Presentation

6.60 Initially, the relief provided consisted of mostly medical supplies and medical teams but subsequently other relief supplies also arrived. Nearly 250 flights arrived at Bhuj with Relief, mostly ready to eat food, tents, grains; tinned food etc had arrived from 50 countries as well as UN agencies and many international NGOs. 12 countries exclusively sent rescue teams, with their own rescue & rehab material. In fact, by 12 April 2001, OSSOC registered the presence of over 245 organizations and agencies, including at least 99 international NGOs, 55 national NGOs, 20 Donor Government teams, 10 UN and inter-governmental organizations and Red Cross representatives from 10 countries. More than 50 Red Cross/Red Crescent members responded in support of the Indian Red Cross, starting with the deployment of the following Emergency Response Units (ERUs):

(i) A 350-bed Norwegian and Finnish Red Cross emergency response referral hospital;

(ii) A German Red Cross water and sanitation ERU;

(iii) A Japanese Red Cross emergency response primary health care unit;

(iv) A British Red Cross logistic ERU and distribution team; and

(v) A Spanish Red Cross mobile medical clinic.

6.61 While the emergency response primary health-care unit and the mobile clinic withdrew at the end of March, the emergency response referral hospital was gradually integrated into the local health system. Israel sent Excavator equipment, cutting tools, power tools; portable generators along with technicians and specialists personnel in seven aircrafts have arrived from Israel. They also set up a civil hospital at Bhuj. It was a self-reliant, air-conditioned with ICU 70-bed medical unit with a laboratory, an X-ray unit, sleeping quarters and logistics group. It was equipped to treat about 1000 patients every day. Most of the international organizations such as the UNDP, WHO, UNICEF, World Food Programme. ILO and the International Migration Organization participated in relief operations. The United States Agency for International Development (USAID) and the Department for International Development also played a key role in relief and rehabilitation process.

6.62 Govt of Gujarat facilitated the participation of international agencies and NGOs in a proactive manner. Officers were assigned coordination work in Mumbai, Delhi, Ahmedabad and Bhuj. NGOs such as Ramakrishna Mission, Sewa Bharti, Mata Amritanandmayi Math, BAPS, Kutch Navnirman Abhiyan, Kutch Jain Samaj, Caritas India and many others, played important roles in providing relief to the affected people. There was spontaneous response from the corporate sector. Reliance, the

Tata Group, Essar, Adanis, L&T, GNFC, Gujarat State Financial Corporation (GSFC), Zydus Cedilla, Hinduja Foundation, public sector banks, the then Indian Airlines, the Gems and Jewelers Merchants' Association, the Videocon Group, the Federation of Indian Chambers of Commerce and Industry (FICCI), Care, the Confederation of Indian Industry and a number of PSUs, played an important role in both relief and rehabilitation.

The Aftermath & Lessons learnt and Initiatives made in the Field of Disaster Management

6.63 An all-party meeting was held on 3 February 2001at the center, chaired by the then Prime Minister, Atal Bihari Vajpayee. It was here a decision was taken to set up a National Committee on Disaster Management. The Government of India, by a notification of 13 February 2001, thus set up a National Committee comprising 35 members with the then Prime Minister as Chairman and Sharad Pawar, than Member of Parliament, as Vice-Chairman. The other members were the Union Ministers of Home, Defence, Finance, Agriculture, Textiles, Urban Development and Parliamentary Affairs, Deputy Chairman of the Planning Commission, Principal Scientific Advisor, the Chief Minister of Gujarat, representatives of national parties and state parties. The Cabinet Secretary was the member-secretary of the National Committee. Thus, for the first time, a national level authority to look into the management of disasters came in to being.

Some Important Lessons & Takeaways

6.64 Many lessons were learnt in the context of the Bhuj earthquake relief and reconstruction efforts. Gujarat has prior experience in handling disasters, especially the cyclones. Data analysis, documentation and systems evolved over the years, have

enabled quick response and effective recovery. At the national level too, there are arrangements to support states at the time of any major disaster. However, post Bhuj earthquake, it was realized that there was an immediate need to further improve and expand the existing systems and refine the procedures. Some of the lessons learnt are enumerated below:

(i) The field-level administration had an experience to combat floods and cyclone but not the disaster of this magnitude. Search and Rescue procedures was found wanting. To upgrade this aspect, procurement of modern equipment, power tools & cutting tools, identifying specialized teams for search and rescue teams, availability of trained dogs, detailed town maps etc has to be done on priority.

(ii) Installation & monitoring of Modern Seismic instruments needs to be reviewed at earthquakes prone areas. A similar approach is needed to improve the flood and cyclone forecasts, dissemination and early warning systems.

(iii) Though there were DM plans at all levels but most of them pertained to the flood and cyclones. A realistic and holistic approach encompassing all possible disasters, keeping in mind the vulnerabilities and topography/terrain of the area must be prepared, reviewed and disseminate to the last person in the hierarchy.

(iv) It is necessary to prepare workable plans with absolute clarity in terms of a command and control system. It may be useful to have a sub-matrix of an overall plan addressing risk assessment and vulnerability analysis, response systems and inventory of resources.

(v) Each district located in areas prone to disasters should maintain an on-line inventory of resources available with the government, public sector and private

sector. This will enable easy and quick mobilization of resources. A statewide on-line resource inventory would enable the mobilization of resources from neighboring districts in the event of a disaster.

(vi) The role of police, paramilitary and Armed Forces may be defined and clearly outlined in the disaster management plans. Organizations such as the State Reserve Police, the RAF, Central Industrial Security Force, Civil Defence, Gram Rakshak Dal and Home Guards should be integrated with the disaster management system, particularly with response plans.

(vii) In the event of natural disasters, particularly in the Saurashtra and Kutch areas, it becomes necessary to mobilize equipment, tents, and boats etc., within a short time. BSF water wing at Bhuj should be made nodal agency to respond to any disaster involving floods and cyclones in Kutch area. Similarly, India Air Force should be involved to air lift rehab material from its aviation bases. It is worthwhile to stock such items for crisis situations by establishing warehouses at three or four locations such as Rajkot, Jamnagar, Ahmedabad and Vadodara.

(viii) Control rooms need to be upgraded particularly at the district and taluka levels with modern communication systems, both wired and wireless as well as Satellite based communication system.

(ix) Training is extremely important. It is necessary to arrange training in a systematic way so that most of the stakeholders are exposed to the latest ideas and technologies in disaster management. At present, the Sardar Patel Inst of Public Administration in Ahmedabad organizes training programmes in DM awareness, but the participation is not satisfactory. Different government departments, public sector organizations and NGOs should ensure effective

participation of their personnel in training programmes. Specialized training facilities for emergency medical management and search and rescue capability should be developed.

(x) In Gujarat, the subject of disaster management is handled by the Revenue Department at the state level, Collectors/DDOs at the district level and Mamlatdars/Taluka Development Officers at the taluka level. Other departments such as Roads and Buildings, Health, Agriculture, Water Supply and Urban Development, participate in disaster management activities. It is necessary to clearly define the arrangements for disaster mitigation and management in different departments. It may not be possible to have dedicated personnel exclusively for this purpose; therefore, officers handling with other portfolios may be identified and given orientation for the DM.

(xi) Utilizing the services of retired personnel of Armed Forces and even retired police personnel in disaster management efforts may be considered. For this purpose, there should be a systematic approach of having a database, providing orientation from time to time and deploying them quickly at the time of disaster.

(xii) Youth organizations such as the National Service Scheme, National Cadet Corps, Youth wings of political parties, student unions, trade unions and the Nehru Yuvak Kendra can play useful roles at the time of a disaster. They have valuable human resources, skills and well defined hierarchy.

(xiii) Special focus should be on fire services with various agencies such as municipal corporations, the GEB and the private sector. The Government of India has suggested to the state governments that fire services need to be trained and equipped to function as all-hazard response units as in many other countries.

This will necessitate some additional equipment and training to the fire units for carrying out search and rescue at the time of disasters. The Government of India has initiated measures to prepare a separate project for this purpose.

(xiv) Media management is extremely important. Developed countries have systematic arrangements for this purpose. This aspect should be considered while designing an operations Centre and preparing disaster management plans.

(xv) In Gujarat, effective steps have been taken to include seismic engineering in the syllabus of graduate engineering courses and also that of polytechnics. For this purpose, training programmes for teachers of engineering colleges have been prepared and organized. It is, however, necessary to continue this on a more sustainable basis. Very often the institutions concerned and the allied departments do not take adequate interest in continuing such activities. It is absolutely essential that they should be given priority and adequate attention.

(xvi) It is also necessary to continue the training of engineers and even masons through regular programmes on a sustainable basis. Unless this is done more frequently, it will be difficult to ensure the availability of skilled personnel for construction that conforms to disaster-resistant standards.

(xvii) Insurance schemes and other measures for disaster mitigation should be expanded and operated more comprehensively.

(xviii) In the past, not much attention was given to developing community awareness, capability and preparedness. Efforts need to be directed to reinforce community preparedness and capability.

(xix) It has been realized, that at the national and state levels, it is essential to have a legal framework for disaster management. Gujarat is the first state in India

to have enacted such legislation. It is necessary to ensure that various provisions of the act are implemented by all the stakeholders.

(xx) Disaster mitigation aspects should be incorporated in development plans and schemes for the areas vulnerable to disasters. In other words, every project should indicate how to address mitigation aspects. Plans or projects especially for mitigation/prevention of disasters may be given priority.

(xxi) Funds which are available under the ongoing schemes with various Depts may also be used for mitigation and preparedness activities for DM activities. For example, funds under the rural development schemes can be used for construction of cyclone shelters in areas which are susceptible to cyclones. Similarly, sites and designs of primary school buildings in flood-prone areas may be selected in such a manner that they can serve as shelters at the time of floods also. The design requirement for primary school buildings and hospitals and other important buildings in seismic zones IV and V should conform to the relevant building codes.

(xxii) Due to the breakdown of communication, there was difficulty in comprehending, for quite some time, the extent of damage. Due to the lack of communication, it took a longer time to organize administrative officers, fire stations, police stations and medical organizations.

(xxiii) Many people who were trapped in damaged structures were rescued by their families and neighbors, which highlighted the role of community preparedness.

(xxiv) There is a need to establish or at least identify a disaster management centre and control rooms' right up to a district level. .

(xxv) It was also found necessary to upgrade the immediate response system.

6.65 As mentioned earlier, post Bhuj earthquake, many initiatives were initiated both by the Government of Gujarat as well as the Govt of India. Some of the initiatives which are as follows:-

(i) Even prior to the Bhuj earthquake, GoI considered the transfer of the subject of disaster management from the Ministry of Agriculture to the Ministry of Home Affairs. This was debated for quite some time. The Bhuj earthquake possibly provided a new sense of urgency. The subject of disaster management when transferred to the Ministry of Home Affairs was at that time headed by the Deputy Prime Minister of India. The Ministry of Home Affairs thereafter undertaken a number of initiatives relating to prevention and mitigation in addition to upgrading of the emergency response system both at Central and States as well.

(ii) A DM programme was introduced by the Government of India in collaboration with the UNDP. Initially, it was envisaged to cover 17 states in India. In each State, vulnerable *talukas* and villages have been identified. The objective is to put a comprehensive multi-disaster-based programme of community preparedness and capacity building in place. It also aimed to prepare disaster management plans at the grass root level viz., district, sub-district and village/taluk levels.

(iii) Another initiative by the Government of India was concentration on the cities which are vulnerable to disasters. A programme known as the Urban Earthquake Vulnerability Reduction Programme was introduced as a part of the DM programme. The idea is to strengthen the earthquake preparedness of

38 earthquake prone cities pan India with a population of more than 500,000 and located in seismic zones III, IV and V.

(iv) The GoI has also taken initiatives for revising the syllabi of engineering colleges in various parts of India, included disaster management as a part of curriculum in the syllabi of schools and training of teachers of engineering colleges through the IITs. There have been important initiatives in upgrading the search and rescue capability and strengthen the State Machinery. The Government of India has made commendable efforts to replicate in other States some of the measures introduced in Gujarat.

6.66 One of the important lessons learnt was that it is unrealistic to expect accurate figures of losses and damages immediately after a disaster that was so severe and widespread. It may be more rational to follow a systematic approach and a realistic time-frame. In the case of Bhuj earthquake, initial figures were way exaggerated both human losses as well as infrastructural damages. Right from day one, there was immense pressure and demand from all quarters including the media, for figures on the death and damage. All sorts of figures appeared in the press. During the initial two days even the senior officials felt that the number of dead could be as high as 60,000. Reports of 8, 10 and 12 Feb 2001 of the State Government indicated figures of 16,487, 16,755 and 18,603 respectively. By the end of February and the middle of March, the figures given were 20,447 and 20,005 respectively. UNDAC report dated Feb 20, gave a figure of 30,000. In fact, on the first or second day after the earthquake the then Union Defence Minister also gave a statement that the death figures could be to the extent of 100,000 people. There was utter confusion and for a long time, the death figures remained about 20,000, based on the records of the police stations and

hospitals. Subsequently, detailed verifications were undertaken by all the agencies concerned. It was then discovered that there were many overlaps as well as duplication of figures. Finally, a committee of senior officers of the State of Gujarat was constituted to verify the number of causalities'. The death figure, based on the committee's report of 07 December 2001, was given as 13,805: including 3,743 men, 5,184 women and 4,878 children[107].

6.67 Similarly, the numbers of houses which had collapsed or damaged initially were estimated to be 2.69 lakhs and 5.44 lakhs respectively. With the passage of time these figures kept on revising. After verification of these numbers, it was realized that some of the buildings which had earlier been indicated as residential were actually commercial premises.

6.68 Estimates of the magnitude of the earthquake too varied because of absence of appropriate technological tools at that time. Initially, it was estimated by the IMD to be 6.9 on the Richter scale. The Geological Survey of India estimated it to be 7.6 on the moment (Mw) scale. The US Geological Survey estimated it at 7.7 on the moment (Mw) scale. The last estimate finally was agreed upon as the most accurate one.

Conclusion

6.69 The Kutch or Bhuj earthquake with a magnitude of 7.7 Mw occurred at 8.46 a.m. on 26 January 2001. Though it lasted for about two minutes, but was enough to rattle the entire State of Gujarat. Chaubari village located north of Bhachau town in the Kutch district of Gujarat was the epicenter. This location was at a distance of about 250 km west of Ahmedabad. This earthquake has provided numerous examples of geo-

[107] *The Kutch Earthquake 2001 Recollections, Lessons and Insights by Pramod K. Mishra, Published by NIDM, Delhi year 2004*

technical and structural failures. Quake will not kill the people but the collapse of buildings, yes. The traditional wisdom of design and construction practices of engineered buildings prevalent in this country came under severe criticism for the first time. It has generated widespread understanding on what needs to be done in this regard. An important issue is the strict enforcement and compliance of seismic codes, building codes; good construction practices particularly in the areas that are vulnerable to earthquakes. A moot point is whether there was sufficient awareness of the seismic hazards among the stakeholders? Much remains to be done on this aspect because detailed guidelines, based on local conditions and sound technical knowledge needs to be formulated. Similarly, systemic relief, rescue and medical aid was found wanting at most of the affected sites. The procedure and distribution of relief and rehabilitation material also drew lot of criticism from various quarters.

6.70 The lessons learnt from this disaster in Gujarat has flagged many issues and led to creation of many statutory acts, rules and guidelines in the field of Disaster Management, not only for the State of Gujarat but applicable ***Pan India. Creation of National Disaster Management Authority, DM Act and NDRF are few among them merits credit and mention.***

6.71 The role of the media is to bring out the facts and present the real situation. However, in this case, some sections of the media did not try to provide information with a broad perspective. They exaggerated the deficiencies and shortfalls, without highlighting, but for some exceptional cases, the excellent work done by many people in many situations. They also tried to sensationalize some aspects. In a situation like this, it is not feasible to provide relief and temporary shelter to thousands of families within hours or in a day. Instead of making efforts for timely procurement of such

materials and deliver relief to the affected persons, they adopted a negative approach. Agencies, especially Media speculated on figures relating to death and losses without any detailed analysis. This alone is sufficient to demoralise and creates panic amongst the people. Therefore, highlighting the requirement of a specialist to brief the media on the day to day development in the DM aspects on a situation. DM Act 2005 also has provision for the same.

CYCLONE – FANI: 03 MAY 2019

6.72 Odisha faced Extremely Severe Cyclone named **'FANI'** on 3rd May 2019 between 0800 and 1000 hours. FANI was one of the rare summer cyclones, the first one to hit in 43 years and one of the only three cyclones to hit Odisha in the last 150 years. It caused havoc in the districts of Puri and Khurda and left massive damage to life, livestock and property of more than 1.65 crore people in 12 districts that it traversed. Due to its geographic and socio-economic condition, Odisha is highly prone to disasters. Its location on the east coast of India makes it one of the six most cyclone prone areas in the world, the coastline of Odisha is highly vulnerability in terms of cyclone landfall. The other major cyclones that hit this State in the last two decades were the 1999 super cyclone, Phailin in 2013 and Titli in 2018.

6.73 Cyclone Fani originated from a tropical depression that formed west of Sumatra in the Indian Ocean on 26 April. Conditions became more favorable by 30 April. Fani rapidly intensified into a severe cyclonic storm and reached its peak by 02 May. The Indian Meteorological Department kept tracking the cyclone, and reported the maximum sustained surface wind speed of 175-180 kmph gusting to

205 kmph during landfall at Satpada (which was about 50 Km from the temple town of Puri). Although human casualties were relatively low as compared to the Super Cyclone of 1999, but still cyclone Fani left 64 dead, affected about 1.65 Crore people in over 18,000 villages in 14 of the 30 districts in the State. Puri, Khurda, Cuttack, Jagatsinghpur, and Kendrapara were the most affected districts of Odhisha. Cyclone Fani left power, telecommunication infrastructure and road & rail services in terrible state. Major roads were blocked due to the uprooted trees, road signage & electric poles and disrupted power supply in several parts of the State for almost two days. High wind speed also resulted in catastrophic damage to houses to about 3.62 lakh dwellings and left many homeless. Damage to agriculture, fisheries, and livestock were also considerably very high. Department of Environment and Forestry estimated that around 21.9 lakh trees were either uprooted or damaged across the State, mostly in the sanctuaries and forest areas. Fani finally weakened before making landfall near to Odisha coast on the 04th May. Fani caused about US$8.1 billion in damages in both India and Bangladesh, mostly in the State of Odisha[108].

[108] *"Global Catastrophe Recap: First Half of 2019", Aon Benfield. Retrieved 12 August 2019*

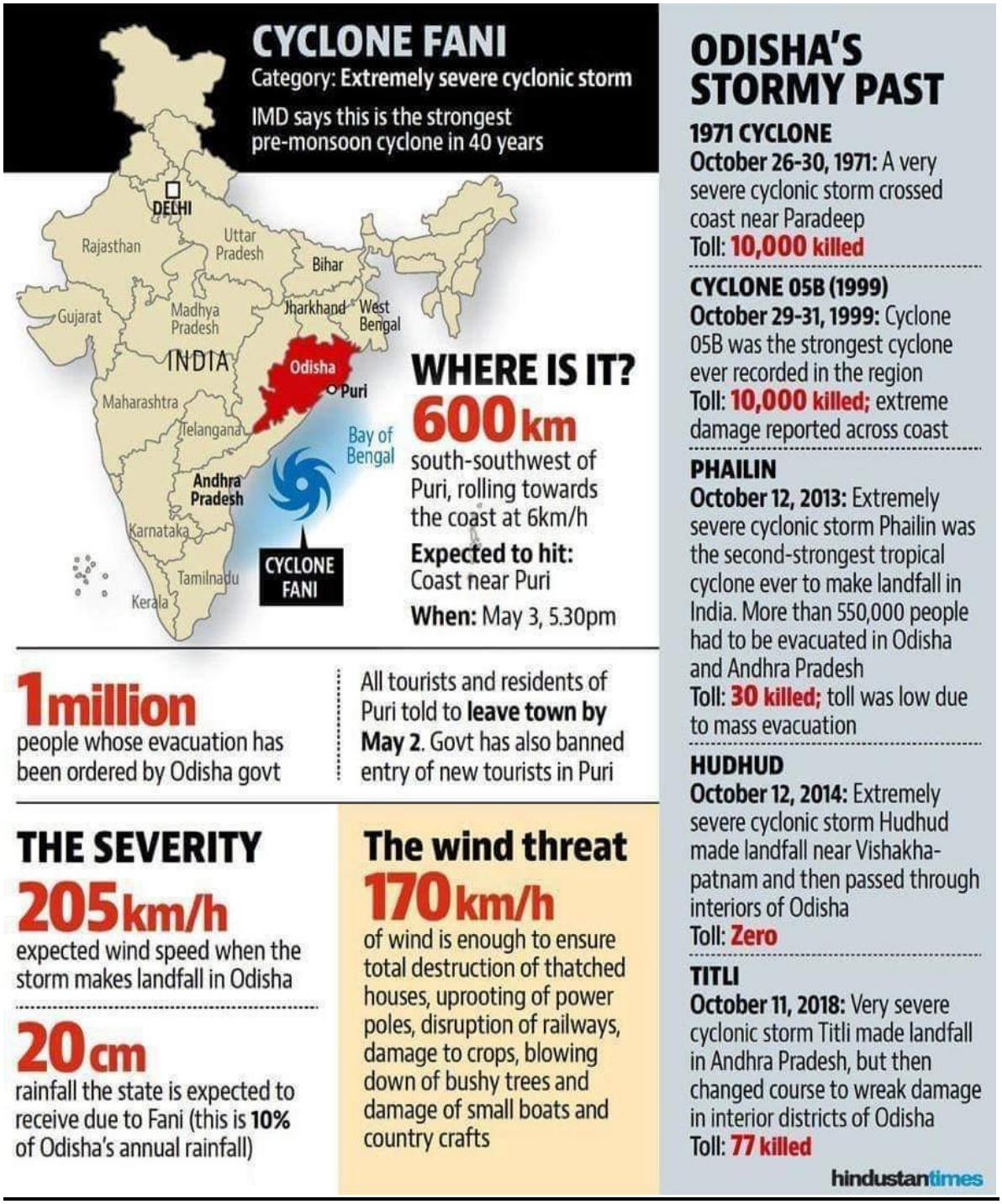

Fig 6.1

Source: Report by Indian Red Cross- Odisha FANI Cyclone Assessment Report Dated May 13, 2019

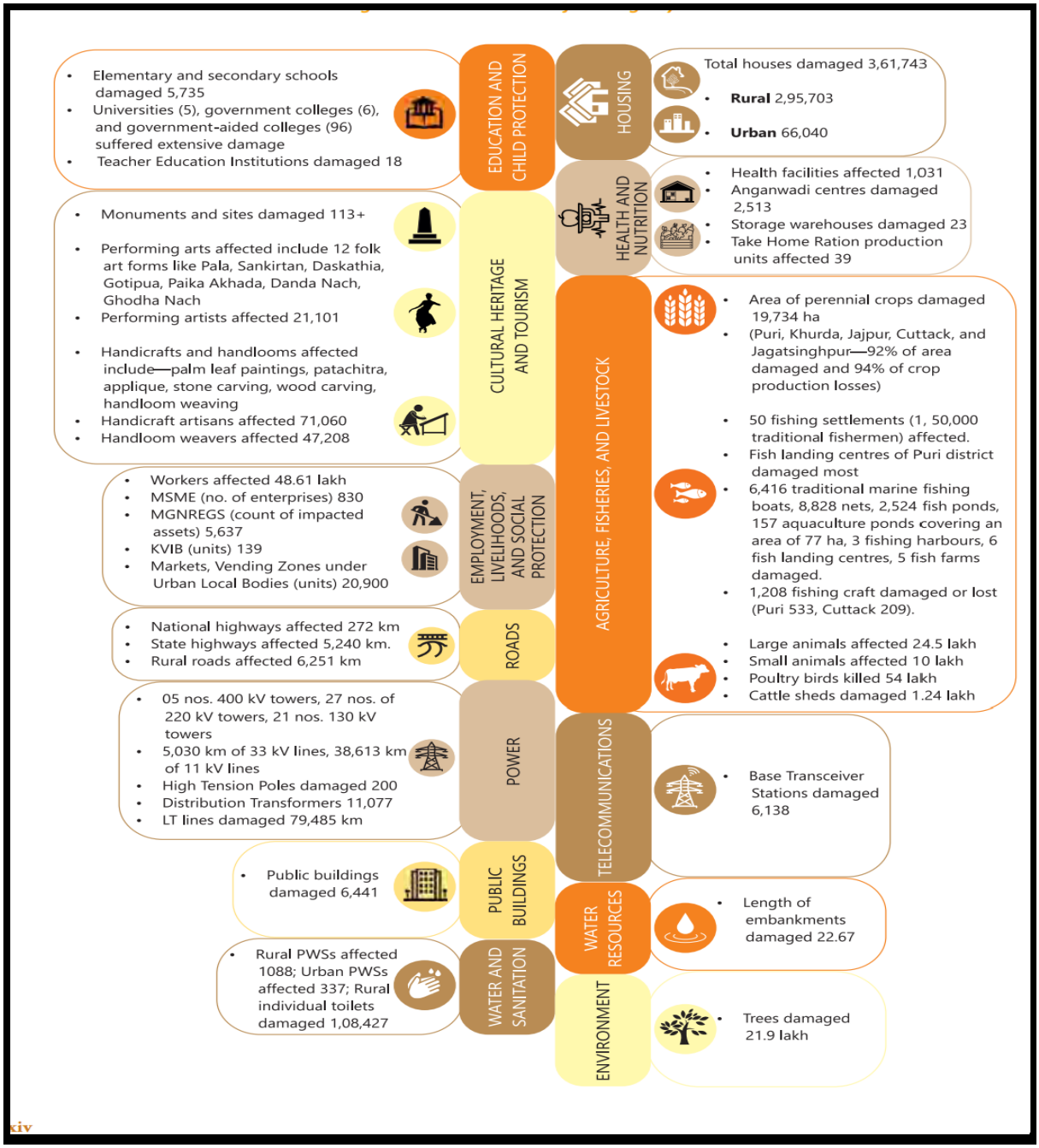

Fig 6.2

Sector wise Assessment of Damage during Odisha Cyclone FANI 2019[109]

[109] *Damage Loss and Needs Assessment report compiled by the state government of Odisha, Asian Development Bank, United Nations and the World Bank and published under the aegis of Odisha State Disaster Management Authority (OSDMA) and Lucid Solutions, www.lucidsolutionsonline.com*

Preparedness, Response and Relief Operations

6.74 Immediately, on receiving the early warnings from IMD, both national and State machinery geared up to tackle and assess the level of preparedness for an effective response after the landfall. Odisha Govt evacuated nearly 1.55 million people to 9,177 shelters including the 879 exclusively constructed multipurpose cyclone/flood shelters and other safe shelters like schools, college and public buildings. About 25,000 stranded tourists were also evacuated from vulnerable areas by mobilizing 23 special trains and 18 buses. All fishing activities were suspended two days prior to the landfall. The government organised massive awareness campaigns to inform people about the basic cyclone with dos and don'ts. Twenty Odisha Disaster Rapid Action Force units; 335 Fire Service units and 25 units of the NDRF were deployed in the coastal districts for search and rescue operations. Air Force and Naval units were kept on standby. Volunteers were mobilized to support the local administration and the community in evacuation, distribution of relief, and shelter management. Instructions were issued to all the departments concerned to make adequate arrangements to provide prompt life-saving assistance to the affected people post cyclone. District and Block Emergency Operation Centers were activated round the clock, with deployment of senior government officials at the district level. Nearly 4.5 lakh polythene sheets for the use of temporary shelters were pre-positioned at district / sub-district levels and 1.5 lakh kept ready for air-dropping after the cyclone. Another first is nearly 600 pregnant women were shifted to *Aanganwadis /* delivery points before the landfall. To ensure food security in the aftermath of the cyclone, food grains were pre-positioned at the fair price shops for distribution among beneficiaries under targeted public distribution system. To ensure safety, prior inspections of Anganwadi

centers, food stocks and essential items were carried out. Emergency Control rooms were set up for distribution of food supplies at district as well as block levels and the progress closely monitored by the State. Food supplies were also pre-positioned in shelter homes, cyclone shelters, and schools to ensure food availability to the community during the cyclone. MHA sanctioned an advance financial assistance of Rs. 340.87 crore to the Odisha government based on the decision of the National Crisis Management Committee.

6.75 **Relief and Rescue Operations[110].** Post landfall, a massive rescue and response operation was launched by the Government. Sixty teams from NDRF, 18 units of ODRAF and 585 fire teams came into action. Nearly 45,000 volunteers were mobilized to carry out relief operations. Indian Naval personnel from Eastern Naval Command also supported the State government in rescue and relief operations. About 10,000 food packets were airdropped by the Indian Air Force and Indian Navy. More than 6,000 free kitchens were opened to serve cooked meals with the help of the local panchayats and self-help groups. Within 48 hours major roads were cleared of trees and debris and power supply restored within two weeks in the major towns of Puri and Bhubaneswar. Specialists were requisitioned from the neighboring States of Andhra Pradesh and West Bengal to reinstate the power and telecommunication services in the State. A special package was announced by the Chief Minister of Odisha on 5 May 2019 with focus on food security, housing, livelihood assistance, environment management and additional monetary assistance. Government of Odisha also submitted an interim memorandum to the Government of India seeking assistance

[110] *Damage Loss and Needs Assessment report compiled by the state government of Odhisha, Asian Development Bank, United Nations and the World Bank and published under the aegis of Odisha State Disaster Management Authority (OSDMA) and Lucid Solutions, www.lucidsolutionsonline.com*

of Rs 17,000 crore. The CM of Odisha emphasized that coastal State needs funds to the tune of Rs 10,000 crore for building disaster-resilient power infrastructure. Similarly, an allocation of Rs 7,000 crore was requested for building disaster-resilient affordable houses from the central. The State government also requested a special allotment under the Pradhan Mantri Awas Yojna with increased support from the Centre (90:10 funding ratio, i.e., 90% funding by central government and 10% by State Government).

6.76 **Disaster Effects and Impact.** Power, farm sector, Housing, telecom sector, livestock, fisheries and livelihoods were some of the most affected sectors. The assessment on the total damage was estimated to be worth Rs 16,465 crore and total loss was Rs 7,712 crore. The estimated recovery needs were pitched at Rs 29,315 crore. The Government said that more than 15.5 lakhs people were taken to safety and also acknowledged that the Centre had provided all necessary assistance in restoring power supply and communications in affected districts, including that of providing necessary stores, generator sets, steel poles and skilled manpower. As a preemptive measure, since other States were also likely to be affected by the cyclone Fani, an amount of Rs 688 crore was released by the Centre in advance to SDRFs of Andhra Pradesh, Tamil Nadu and West Bengal to mitigate the wrath of the cyclone. The Govt of India reviewed the prevailing practices of deputing an Inter-Ministerial Central Team (IMCT) after the receipt of a memorandum from the State in the wake of any severe calamity. In a significant decision taken by the Union Home Minister Mr Amit Shah, the IMCT will henceforth be constituted immediately in the aftermath of any natural calamity of severe nature. The team’s mandate would be to visit the affected areas in the State immediately and carryout first-hand assessments of damages

caused and oversee relief work carried out by the State administration[111]. If need be they are also empowered to recommend requirement of additional relief from the Centre if any.

Sector-wise Damage, Loss, and Recovery Needs

6.77 **Housing.** The damage to housing has been extensive, particularly in Puri district. A total of 3.62 lakh houses (2.96 lakh in rural and 66,040 in urban areas) were damaged, of which 95% was in Puri, Khurda, and Cuttack[112]. The most affected were people in rural areas, urban slums, and those in settlements along the coast line living in kutcha (thatched) / semi-pucca houses with low resilience against cyclonic winds.

6.78 **Education and Child Protection.** The impact on the education sector has been limited mainly to infrastructure, i.e., schools and higher education institutions. In the district of Puri, few old and dilapidated buildings which could not withstand the high wind speed collapsed. In some of the newly built higher education institutions, failure of non-structural elements like false ceilings, window glasses, unsecured gadgets and equipment coupled with damage to the boundary walls was mainly due to falling of trees. Total damage in the education sector was estimated to be Rs 814.48 crore. Total estimated recovery needs were pitched at Rs 503.28 crore.

6.79 **Health, Food Security, and Nutrition.** The total damage cost to health infrastructure for the 14 affected districts amounts to Rs 73 crore. The total loss due to the disruption of health services including governance shortfall and associated risks amounts to RS 232 crore. The total recovery needs for the 14 affected districts amounts

[111] *Press Trust of India, New Delhi, August 20, 2019*

[112] *Damage Loss and Needs Assessment report compiled by the state government of Odisha, Asian Development Bank, United Nations and the World Bank and published under the aegis of Odisha State Disaster Management Authority (OSDMA) and Lucid Solutions, www.lucidsolutionsonline.com Pp Xiii*

to Rs 165 crore. For the nutrition sector, the total damage to institutions is estimated to the tune of Rs 55 crore. Total loss is estimated at Rs 30 crore. The total recovery needs were estimated at Rs 291.79 crore approximately. Recovery of the health sector would focus on the "Safe and Green Hospital" initiative, which is more than just protecting buildings. It is about ensuring that health facilities are accessible and functional at maximum capacity, immediately after a disaster strikes.

6.80 **Cultural Heritage.** The total damage and loss incurred in the cultural heritage and tourism sectors amounted to Rs 560 crore and Rs 1,335 crore respectively. While tangible cultural heritage like monuments and sites were not affected much but, there was a significant loss of livelihoods in this sector. The performing artists, particularly folk artists in rural areas and the artisans and sectors. Total estimated damage and loss in this sector accounts to Rs 3033 crore. Total estimated recovery needed was Rs 2,615 crore approximately. The agriculture sector, which also includes horticulture and cash crops, was severely affected, accounting for 55% of the total damage and loss in the sector. The destruction of perennial crops will cause temporary loss of livelihoods, employment, and agri-income, and will result in increase of post-disaster government expenditure (including compensation for crop losses or other support to various crops damaged in the cyclone). Similarly, around 24.5 lakh large animals, 10 lakh small animals and 54 lakh poultry birds were badly affected due to cyclone Fani. Damage and losses to livestock were estimated at Rs 1,206.81 crore, representing around 39.7% of the total losses to the sector, including production losses, death of animals, and decline in eggs and milk production. The total damage and loss in the fisheries sector including damages to aquaculture and infrastructure is calculated at Rs 158.35 crore amounting to 5% of the total damage and loss in this sector.

Damage and Loss to the coastal/marine fishery and Chilka fishery remained high. Some of the badly affected districts were Puri, Jagatsinghpur, Cuttack and Khurda areas. Revival and restoration of assets lost both in fisheries and aquaculture, along with stocking of fresh stock, was the KRAs of the Government.

6.81 **Power.** Damage to the power sector was very high. The power infrastructure in the 14 affected districts consisted of about 500 substations and 1,10,000 distribution transformers. These were connected with a total of about 14,000 transmission lines and 1,90,000 km of distribution lines. Damage to the transmission system was minor; mostly damages were to the distribution system including about 80,600 km of distribution lines, 202 distribution substations, and 13,400 transformers. The total damage was assessed at Rs 8,139 crore that was required to bring back the system to the pre-cyclone level. Due to these damages and consequent power outages the estimated revenue loss to the utilities was Rs 253.5 crore.

6.82 **Telecommunications.** Telecommunication services in coastal Odisha were severely impacted after the landfall of Fani, damaging telecom infrastructure and disrupting mobile and internet services in eleven most impacted districts. Preliminary damage and loss in the sector was estimated to be about Rs 447 crore, with corresponding recovery needs to the tune of Rs 482 crore, including public sector BSNL and private operators.

6.83 **Roads.** The damage to the road sector was moderate. The major causes for road damages were because of uprooting of trees, collapse of the compound walls and blockage of drains and footpaths. Damage to road furniture such as signage gantries, traffic signals, street lights, towers, poles and road signs was very high. A total damage of Rs 326.2 crore was assessed for all roads including national

highways, State roads and rural roads. Overall recovery need was estimated at Rs 425 crore.

6.84 **Water, Sanitation, and Hygiene (WASH).** Fani has impacted the WASH system and infrastructure both in rural and urban areas. In rural areas about 1,088 piped water supply schemes (49%) suffered structural, mechanical, and electrical damage. About 1,00,926 (18.9%) toilets constructed under Swachh Bharat Mission (Gramin) were partially damaged in the districts of Bhadrak, Khurda and Puri, while 7,758 (1.4%) were completely damaged due to the cyclone. Total damage to rural water and sanitation infrastructure in the seven districts was estimated at Rs 99.04 crore. Losses estimated at Rs 100.4 Crore. FANI caused considerable damage to water supply system in several village blocks affecting 337 urban water supply systems. The overall damages to the urban WASH facilities were about Rs 167.47 and losses were estimated at Rs 28.65 crore. Most of the damaged systems were however temporarily repaired promptly. The total recovery needs in the WASH sector including the reconstruction of damaged toilets was estimated at Rs 819 crore.

6.85 **Public Buildings.** It was estimated that a total of 6,441 public buildings suffered damage worth about Rs 539 crore. Though the number of public buildings that suffered damage in the districts of Khurda, Puri, and Cuttack are in the same range, Khurda suffered maximum damage as they were mostly thatched or kuchha ones. The estimated damage in Khurda was Rs 288 crore (53%), followed by Puri at Rs 125 crore (23%), and Cuttack at Rs 48 crore (9%).Thee major worry in this sector was the need for developing standard construction guidelines, implementation of nonstructural safety and building redundancy and to ensure that the critical buildings are accessible and operable during and after a major disaster, which was found wanting.

6.86 **Water Resources.** The total estimated damage in the water resource sector was Rs 5 crore. The estimated recovery needs were estimated at Rs 86 crore. Major concern was to establish the design criteria for raising and strengthening of embankments, establishing enhanced technical specifications and performance criteria/characteristics, provision of sluices where necessary, and protection of river/seaside slopes and toe of the embankments by stone rip-raps, gabion mattress, toe wall, etc., as applicable.

6.87 **Employment, Livelihoods, and Social Protection.** The estimated damage amounts to Rs 498 crore and income loss in 14 districts amounted to Rs 4,105.13 crore. The total recovery needs were assessed as Rs 3076 crore. The Khurda Industrial Estate was affected and needed to restore for early resumption of industrial activity.

6.88 **Environment.** A large number of trees have been damaged, particularly in the landfall area between Satpada, Puri and Konark, mostly in Ramsar wetland, Chilika, and the Balukhanda–Konark sanctuaries and forest areas. About 9 lakh trees were damaged inside the forest and protected areas alone. The cyclone and associated storm surge resulted in the opening of four new bar mouths in Chilika. A huge number of trees have been uprooted in the three severely affected districts of Puri, Khurda, and Cuttack. Post cyclone, dried trees and their debris in the affected areas posed forest fire threats. There was no significant wildlife loss. Nature based solutions such as coastal shelterbelts around Chilika were damaged but have demonstrated their significance in reducing the consequences of the cyclone. Post cyclone, the quantum of tree debris, infrastructure debris, household dry waste and plastic increased considerably. In the environment sector, the damage and losses to the natural assets and related infrastructure were Rs 181 crore. The recovery needs were estimated at Rs 315 crore.

6.89 **Human Impact.** Cyclone Fani has had comparatively higher and differential impact on the socially vulnerable and marginalized population groups, especially women and adolescent girls, children, members of the SC and ST communities, disabled personnel, fisher-folk, daily wage earners such as brick kiln workers, small traders, artisans and urban slum dwellers. Poverty, location of residence, inequality, social and gender discrimination were some factors that further compounded the pre-cyclone vulnerabilities of these groups and resulted in a differential impact. An analysis considering the five dimensions-Health, Education, Agri-livelihood, Living standards, and Safe housing, across the affected districts shows that Fani has further increased the incidence of income poverty in Odisha which was temporary but needed special attention. In future, an approach with community-specific, occupation-specific and location-specific interface, involving all the stakeholders would prevent the increase of such incidences in this sector.

6.90 **Disaster Risk Reduction (DRR).** Since the devastating Super Cyclone of 1999, Odisha has taken major strides in developing a robust disaster management system for the State. By evacuating more than 1.5 million people the government was able to minimise fatalities (only 64 compared to nearly 10,000 in 1999). However, the damage to infrastructure and economic losses have been very high, clearly indicating the need for integrating DRR measures across all sectors of development. The estimated damage in the DRR sector was Rs 5.5 crore. The estimated recovery needed was approximately Rs 277 crore. The immediate recovery needs were improving preparedness through strengthening Early Warning Dissemination System, revision of disaster management plans and SOPs, strengthening Government Organisations-NGO coordination to respond to the early recovery needs and building capacity on

construction of resilient infrastructure. Some of the important mid- to long-term recovery needs will include setting up of a disaster management information system at the district level, implementation of special disaster risk management programmes for people with disabilities, State wide hazard risk and vulnerability assessment and strengthening of the State response force.

6.91 **Macroeconomic Impact.** Damage, loss, the need for recovery, and disaster resilient reconstruction will impose a substantial fiscal burden on the State. Innovative ways to finance disaster risk and investment in DRR, and mitigation in a manner that does not jeopardize the financial condition of households as well the State, is the need of the hour.

Major Takeaways

6.92 Tackling recent cyclone Fani has brought many laurels to the country and some valuable lessons and takeaways. The strong demonstration of science and technology behind all aspects of preparedness and consequent administrative action to save the people and property was indeed highly laudable. This has also brought our capabilities to the forefront and demonstrated to the international communities our capabilities to deal with natural calamities in a big way. The accurate forecast of cyclonic storm, mapping its course and predicting the likely affected areas with high accuracy have been possible through meticulous collection of meteorological data and its computational modeling. Another important aspect of mitigating effects of a cyclonic storm is to facilitate and achieve the ability of mass movement of people to safer areas at a short notice. Typically, safer areas are made up of buildings or shelters, which are resistant to high winds, storm surges and rains and where the velocity of swirling winds gradually diminishes. Thankfully, the Govt of Odisha was prompt in identifying

these. From the study of Cyclone Fani; we can identify four major takeaways. They are:-

(i) **Build a Relief Infrastructure.** Until 1999, the State of Odisha didn't have a well laid out plan for disaster management. Two months after the super cyclone hit, the Odisha State Disaster Management Authority was set up and plans put in place. Around 900 cyclone shelters were built in vulnerable pockets of the State which resulted in evacuation of hundreds of thousands of people during Fani. In 2001, Odisha Disaster Rapid Action Force was set up to conduct rescue operations and relief distribution. Clear protocols and hierarchical plans for carrying out relief operations were in place. As a result of futuristic vision of the State Govt, huge human losses could be successfully averted during major cyclones in the past namely, Phailin in 2013, Hudhud in 2014 and Fani,

(ii) **Accuracy of Early Warning Systems.** Over the years, the India Meteorological Department has developed effective forecasting tools to predict accurate timings of cyclone formation in the Bay of Bengal and probable landfall days along India's coastline. This early warning system enabled the State of Odisha to be disaster ready and minimise loss of lives. All the agencies were able to gear up and react to the requirement in time.

(iii) **Clear Communication Plan.** Govt agencies sent roughly 2.6 million text messages to the local population in clear language before cyclone Fani could landfall. This alerted the people and they could adopt necessary precautions before the cyclone could even make landfall in the State, thereby saving many vulnerable communities from catastrophe. Regular press, both print and electronic briefings were conducted by officials to update people of the

impending cyclone. Vulnerable sections were repeatedly advised over all forms of media not to get panic and gave clear ***instructions as how to go about in the event of eventuality.*** This helped the State to evacuate a record 1.2million people to safe buildings and shelters before the Fani could strike the State.

(iv) **Effective Co-ordination of Groups.** Preparations to combat the contingencies of Fani, involving a number of government agencies as well as local community volunteer groups were formulated. The government's disaster response forces were placed at all vantage locations. Food and water packets for air-dropping were made ready for Air Force and naval helicopters well in advance. Senior State officials and police officials were sent to the affected districts to co-ordinate relief and rescue operations and coordinate with various agencies involved.

6.93 **Conclusion.** The destruction of physical properties cannot be controlled when a storm of such magnitude crosses a densely-populated landmass. What is commendable this time around is the low number of human casualties. The Odisha government which has earned international praise for its magnificent efforts was successful in doing this because it has effectively learnt the lessons from the 1999 experience of handling the super cyclone and thereafter built a disaster mechanism system based on that experience. Odisha has proven its emergency disaster preparedness commendably.

6.94 It is important to recognize that recovery is an effort that goes beyond humanitarian assistance, leads to rebuilding assets and livelihoods, improves government services, and builds resilience at all levels. Recovery should, therefore, be organised as a distinct effort, targeting people who are heavily affected by cyclone FANI. While 10,000 lives were lost in 1999 Super Cyclone, the tally this time is down

to 64. Although the emergency response can be further strengthened to ensure zero deaths, there is also a need of urgent measures to build preventive and resilient buildings and infrastructure to minimise damages and cost of restoration. Climate-resilient development is not a choice any more but the only option.

6.95 However, while the government must lead the recovery effort, support from all the segments of society like NGOs, private and public sector and international development partners should also come forward in the rehabilitation process. A more inclusive and collective recovery effort would help the State reach out to all the affected areas and communities and reduce the burden on the State. People are active participants in recovery, and the government must create enabling conditions and sensitize them frequently for their active participation and contribution. A sustained recovery effort would bring accelerated development to the State of Odisha. Recovery should, therefore, be taken as an opportunity for building resilience, meeting the Sustainable Development Goals, and improving the well-being of the people in the need of hour.

6.96 There is no denial that Cyclone Fani has left a fury of damage to properties and public infrastructure. The post-cyclone recovery was a daunting challenge to the administration of Odisha, demanding a lot of resources, financial aid and Central Government support. Post 1999 super cyclone, the State relied on a number of community-based groups and volunteers to help rebuild the affected communities. The same is relevant today also, but they are in a much better position thanks to the disaster preparedness and risk mitigation followed before the storm hit.

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CHAPTER – VII

CHALLENGES IN DISASTER MANAGEMENT

7.1 **Challenges for the Future.** The impact of disaster is long lasting. India in the past has suffered huge losses and setbacks in development due to disasters. Disasters can have devastating effect on communities and can significantly set back progress of the economy. Our disaster response plans are often hampered by procedural confusion and by policies that do not facilitate effective management. Disaster is a sudden, catastrophic event bringing great damage, loss, and destruction and devastation to life and property. The damage caused by disasters is unquantifiable, and varies with the geographical location, climate, topography and the type of the earth surface and directly relates to the degree of vulnerability. ***This influences the Mental, Socio-economic, Political and Cultural state of the affected areas.*** Our country is vulnerable to a large number of natural as well as man-made disasters. Vulnerability to disasters / emergencies of Chemical, Biological, Radiological and Nuclear (CBRN) origin also exists especially in the wake statements given by our main adversaries Pakistan and China of late. In spite of major ***advances in the field of science and technologies, Increased exposures to disaster risks can be related to exponential mounting population in a given area, urbanization and industrialization, rapid development within high-risk zones and lastly, climatological changes due to the Global warning, the damage to people and property continues to be high.***

7.2 There is a growing need to look at disasters from a development perspective. Disasters can have devastating effect on communities and can significantly set back developmental efforts to a great extent. The Challenge before us, therefore, is to strive

towards higher levels of understanding, preparedness, mitigation efforts and response mechanism. This in turn needs to be backed by better coordination amongst different ministries of the Central and State, Panchayat raj Institutions, academic institutions,

7.3 ***Role of Corporate sector under CSR, civil societies, NGOs and citizen at large.*** ***Towards strengthening the Disaster Risk Reduction effort, we must consider certain major challenges in a Disaster Environment. Ignoring these may have wider connotations; before, during, and after disasters with the potential to significantly increase loss of life and may impede recovery efforts. Some of the challenges that would require immediate attention and review for policy makers are:-***

(i) **Search & Rescue of the Missing Personnel and Evacuation of Trapped Personnel/Livestock.** Sudden onset of major natural disasters – such as Earthquakes, Tsunamis, and Storms/Cyclones causes' lot of damage infrastructure and many a times leave a trail of dead and injured. An immediate response is required to rescue the injured, people who are trapped under the debris and thereafter, evacuate and stabilize the survivors. Initial response to search and rescue operations is extremely critical as the difference between life and death can be a matter of hours. These efforts require specialised skills and very often need heavy or specialised technical equipment and power tools. The operational context may be extremely challenging, as responders working in debris fields require great expertise and cutting edge technologies for quick evacuation and emergency care. This was found wanting in the Bhuj earthquake, when hundreds have lost their lives for lack of timely intervention. Finally, Israelis have set up an emergency Medical camp and Swedish and Swiss SAR teams along with sophisticated cutting tools teaming up with the

Indian Army units were able to carry out the tasks effectively.

(ii) **Supply of Essentials like Water, Food, Clothes and Baby Products.** In India mobilization of these essentials in emergency is a herculean task due bureaucracy and redtapisum. Even today, Government agencies and NGOs depend on the donations and help from their citizens. It becomes more critical in the event of Cyclones, Tsunamis and earthquakes.

(iii) **Restoration and Maintenance of Electricity & Communication lines.** Any crisis / disaster can lead to disruption in generation, transmission and distribution and supply of electricity. It is thus, extremely important to evolve a comprehensive plan to restore the generation, transmission, distribution and supply of electricity to the affected areas at the earliest with minimum collateral damage. Distribution sector is under the purview of State government in which magnitude of damage to infrastructure is high. Underground Hydro stations in operation as well as ongoing area are more prone to emergencies. The activities that enable the various agencies involved in generation, transmission, distribution and supply of electricity to plan for, quickly respond to and to recover from unexpected events and situations and provide power supply at the earliest, To reduce response time in organizing the assistance and to identity major resources, man power, material & equipment needed to make the plan operational are some of the major challenges in any Disaster scenario.

(iv) **Medical and Sanitation Services**. One of the biggest challenges in any DM scenario is the need for a robust disaster management plan to cope with calamities by way of effective tackle of medical and sanitation issues, especially spread of communicable & non-communicable diseases, impacts of vector and

water borne diseases such as leptospirosis, cholera outbreaks & provide public sanitation, and most importantly restore medical facilities. The last few decades has highlighted the fragility of health systems in India in every DM situation. Floods in the State of Kerala (2018) damaged a 125-year old hospital that served 350,000 people. This was similar to the Chennai floods of 2015 where 18 patients died due to a power failure in the hospitals or the high risk of infections during annual urban flooding in Mumbai (Barnagarwala, 2017) or Killer Plague in Surat. In a notably tragic example of disaster impact to a health facility was the collapse of the 281 bed civil hospital during the Gujarat earthquake (2001) that killed 172 people. Post the Indian Ocean Tsunami (2004), health infrastructure damage and reconstruction costs amounted to USD 30 million (Carballo et al., 2005). Large scale failure of health systems is also known to result in a negative impact on a region's economy too (ADB, 2005). The government bears much of these costs of damaged health infrastructure and poor health consequences113. Some of the other challenges in this sector would be Healthcare infrastructure, activation of Mobile Hospitals, Media Management, District Level Data Collection, Standard Operating Procedures Response, Contingency Plans, Preparedness and Mitigation, Vulnerability Assessments, Mass Casualty Plan, Ambulance Network, Hospital Networking, First Aid, Training and Capacity Building. Various agencies involved in Public Health and Disaster Management in India is given below:-

[113] *Ref Working Paper No. 241, Health and Disaster Risk Management in India by Supriya Krishnan and Ila Patnaik, published by National Institute of Public Finance and Policy New Delhi*

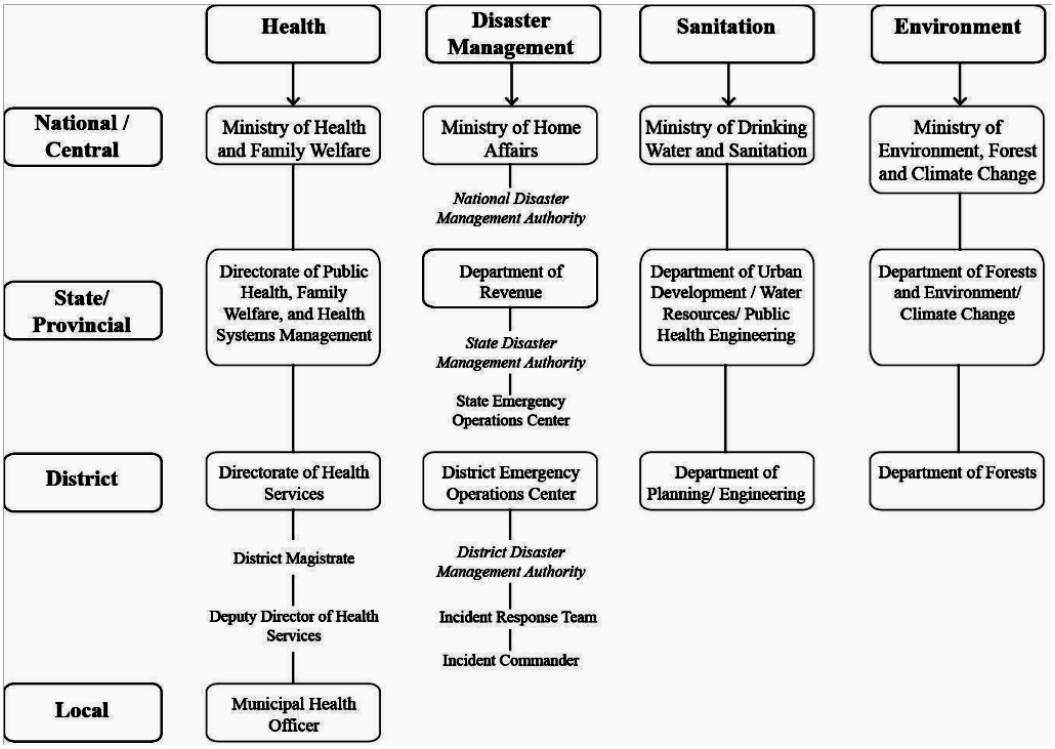


Fig 7.1

Drawn by NIPFP with Data from Planning Commission and Allied Documents.

(v) **Provision of Makeshift or Temporary Shelters, Alternate Accommodation and Setting up of Relief Camps[114].** Disasters, time and again leave significant impact on the environment – there would be colossal damage to the infrastructure, damage to the houses, public buildings etc. Many people often abandon their homes after major disasters and public buildings would become inoperative for months, leaving affected and hapless people to misery and grief. It is heartening to note that the NDMA has drawn up National Guidelines on temporary shelters for families affected, or displaced in the wake of natural disasters. These guidelines not only

[114] *National Guidelines on Temporary Shelters for Disaster - Affected Families A publication of: National Disaster Management Authority Government of India NDMA Bhawan A-1, Safdarjung Enclave New Delhi – 110 029 Dt September, 2019*

focus on the immediate short-term needs but also on long-term housing and habitat recovery. It draws upon national and international experiences, lessons learnt from field engagements and feedback from relevant stakeholders to express guiding principles, implementation arrangements and roles and responsibilities of all stakeholders. These guidelines can seamlessly be adapted to meet varied local needs, both rural and urban, across the country and would bring succor to people and communities adversely affected by disasters. Disasters like Tsunami, Earthquakes and Cyclones leave thousands of people homeless for weeks if not months. They need to be shifted to various Evacuations Centers (EC), which are Disaster centric, as not every EC would suit every type of disasters. Some of the shelters would be temporary like cyclones or floods and some require longer duration like in the case of earthquakes. The ECs are pre-identified buildings like schools, colleges or some public institutions. Most of the Coastal areas in AP, Odisha, TN and West Bengal have already identified many such buildings. Short duration ECs are usually set up during Cyclones and Floods. The longer ones are often established when permanent damage to houses or structures occurs, such as in earthquakes (Bhuj & Latur as in the past), flashfloods/cloud burst (Kedarnath), Tsunami (Carnicobar and some of the mainland states of India) or volcanic eruptions (though none in the Indian sub-continent). In such long duration ECs, the most common consequence is the permanent resettlement of the displaced community. Immediate task of any Government/NGO would be to mitigate this issue. In lesser emergency situation, affected people would be shifted to the safer places or setup relief camps till the danger is obviated or make temporary pre-fabricated shelters. While the permanent structures are a long drawn procedure

with most of the facilities in place, the immediate challenge would be during setting up of temporary accommodation and relief camps. Some of those challenges would be:-

(a) Must be accessible : easy access to roads, supplies of food, shelter materials, cooking fuel and communication

(b) Adequate vegetation for shade; if soil condition permit future cultivation may be an option

(c) Presence of electricity with source of water

(d) Good drainage (avoid marshy ground; should be above flood level

(e) Secured, less possibility of conflict/hostilities with the non-affected population in the vicinity

(f) No environmental health hazards, i.e., extremes in temperature, strong winds, exposure to habitat of vectors of diseases (ex. Dengue, Malaria, Chikungunya, filarial etc)

(vi) **Provision and Restoration of Drinking Water Supply.** The most important and critical contingency in any disaster phase is the supply and restoration of water, both potable as well as for normal use. As with all other aspects of emergency management, water supplies can be designed and maintained in ways that help to reduce the health impacts during disasters. NDMA has issued guidelines on the minimum standards of relief. In an emergency situation, the first priority is to provide an adequate quantity of water and to protect water sources from contamination. However, safety of water especially those used for drinking and cooking is of very critical. Water sources are exposed to a variety of hazards that may damage or contaminate them during

any type of disasters. Major challenges in this area would be:-

(a) To assess immediate population needs vis-a-vise availability of water supply.

(b) Protect upstream water supplies and wells; treat all surface water as polluted.

(c) Provide basic collection, storage and treatment facilities for protected sources.

(d) Prevent indiscriminate defecation through rapid provision of facilities.

(e) Provide safe disposal of excreta and refuse, controlling rodents and pests.

(f) Integrate hygiene promotion within community.

(g) Consider establishment of long term permanent arrangements and ensure their implementation will not be hampered in the future; in particular, ensure continued safety of local water resources which may be scarce during any impeding contingency.

(h) If the potable water needs to be transported from a distant place, (like during Chennai floods scenario), mode of transportation, storage and re-distribution need to be worked out well in advance as it would be a herculean task later. Standing instructions or running contract should be pre-identified.

(i) It is always better to consolidate separate human and material resources for providing water supplies for hospitals, nutrition centers, etc., so that work on the general water supply is not delayed. Hospitals will soon be flooded with cases of water borne diseases if the general water supply is not

potable. However, priorities should be worked out for each situation, on the basis of assessment and the dynamics of the disaster.

(j) Supply of provisional water supply may be explored from dairies, soft-drink bottling plants, breweries or even large swimming pools. However, tapping these sources is time consuming and at times ***may face*** confrontation from the business community.

(k) Damage assessment should consider the following types of damage:-

(aa) Identification of contamination of the water source and damage of the raw-water intake.

(ab) Extent of damage to the water-treatment works, including structural, electrical and mechanical. Damage.

(ac) Extent of damage and loss of power supply and contamination due to flooding.

(ad) Extent of damage to pumping stations.

(ae) Extent of damage to both sewerage and water mains in the same locality, with local seepage into water pipes where the pressure is reduced.

(af) Or badly repaired plumbing in domestic or public buildings, resulting in back-siphonage;

(ag) Failure to disinfect a contaminated source correctly, or to maintain adequate chlorine residual throughout the system.

(ah) In rural areas, the damage and resources assessment would be relatively simpler. Following information on water resources should be required for effective execution:-

(aaa) The current availability of supplies from all sources, their causes of supply problems (e.g. dry streams and wells, pipe breaks, dams empty, tanks damaged or silted up, roof catchments destroyed, etc.) and alternative sources of supplies and their status.

(aab) The causes or indicators of contamination (e.g. human or animal bodies in the water, discoloration of the water, high turbidity, unusual smell, saltiness, diarrhea or other possible water-related illnesses in the population).

(aac) Though less complicated than urban assessments because of lesser complexities, rural damage and resources assessments generally takes longer time to carry out because of the vast distances involved. Information nevertheless, can be collected by local health organisations and community workers, using standardized procedures and reporting formats, to enable priorities to be set.

(vii) **Excreta Disposal.** The ideal ratio is 1 lavatory per 20 persons and if living in community, at least 1 per family. This is seldom met especially when the whole relief camp or affected village/town/locality with a population of about 500 or above are evacuated into ECs with limited room-space. Besides overcrowding, it is presumed that the toilet facilities in the schools/colleges will not be adequate, as well as those in the EC camps. The problem of lavatories may be resolved with augmented additional portable toilets. But it requires good planning, proper site selection, education among the target users and proper disposal of collected excreta is ensured since failure to do so will result in the

increase in flies, foul smell, and most importantly potential spread of communicable diseases.

(viii) Given that most modern municipalities are vulnerable to many natural hazards, the ECs for evacuation have to be pre-identified. Therefore, the, construction of additional toilets can be planned in the pre-disaster phase. In the similar manner, construction of additional ECs and their site identification for the makeshift camps can be done.

(ix) Restoration of Rail, Road & Airport Connectivity (as was experienced in Mumbai, Kerala, Vadodara & Chennai floods). Cyclones, floods and earthquakes often lead to disruption of rail/road connectivity leading to chaos and hardship to the stranded commuters or sufferers. Though shutting down of the airports are rare, but experience in the past during Chennai, Kerala, Mumbai and Vadodara floods indicate that there is yet another dimension added to the ever growing threat to the various transportation modes. Transportation is often considered a critical infrastructure since a disruption in one of its components can have significant impact on the economic, social wellbeing and recovery process of a region during emergencies. The biggest challenge is how to assess the criticality of an infrastructure considering the impacts it would have on the flows and activities of it services, whether rail, road or shipping lines as a matter. From an economic standpoint, the impacts of disasters are dependent on three factors; one, the nature and level of incidence of disasters; two the level of exposure of populations and infrastructures and three the level of vulnerability of populations and infrastructures. The disruptions caused by disasters take place over complex transport system and are consequently difficult to evaluate. Particularly, the

non-linearity character of complex systems implies that a disruption can have multiplying and feedback effects, many unforeseen. A disaster of this severity is likely to trigger a phase transition where the resulting transport conditions are very different to those already in existence. The flexibility of a transport system is its capability to resume normal operations at the shortest possible time.

(x) The disaster can never be effectively planned nor can be anticipated, however, there are a series of steps, known as Disasters Risk Management, which could reduce disruptions and restore the normalcy at the earliest. They are:-

(a) **Risk Assessment.** The possibility of an event and its potential impacts should be systematically assessed, such as low to high probability over a defined time frame and over a specific area (e.g. a city or region). This will help in prioritizations of risks during the assessment phase.

(b) **Preparedness.** As foreseeing the quantum of damage is hard to come by, keeping In light of the potential risks, a level of preparedness should be considered in terms of potential responses. This can involve the warehouse/depot facilities and positioning of adequate relief material (to last at least 2-3 days), such as fuels like diesel, petrol and kerosene, food grains, essential goods, milk powder, emergency pre-cooked and tinned food with adequate shelf life, rehabilitation equipment etc. Similarly, adequate training to the stakeholders along with the training to the labor force in emergency situations should also be imparted.

(c) **Mitigation.** Apprehensions to the immediate reaction in the event of disasters can involve the shutting down of transport systems (particularly public transit), the evacuation of populations and the mobilization of first response

resources, namely distributing emergency relief (for e.g., food, medical supplies, water etc). The objective is to control and offset the disruptions caused by disaster.

(d) **Response.** Steps are to be implemented to bring back capacity and normalcy with existing infrastructure once the disaster has been mitigated. If a particular mode is impaired, the usage of alternative modes and infrastructure has to be considered. The goal is to maintain every possible system operational within the laid down timelines.

(e) **Recovery.** Concerns all the steps necessary to recover the capacity, which was lost during the disaster. It can involve repairs, replacement and cannibalization to the lost capacity and ensuring resumptions of goods and services to resume normalcy. DRM process can be depicted by the following table:-

Mitigation: • Hazard prediction and modeling • Risk assessment and mapping • Spatial planning • Structural and non-structural measures • Public awareness and education	**Preparation:** • Scenario development • Emergency planning • Training • Capacity Building
Response: • Dispatching of resources • Emergency telecom • Situational awareness • Command control coordination • Information dissemination • Emergency healthcare	**Recovery:** • Early damage assessment • Re establishing life-lines, transport and communication infrastructure

Table 7.1

(xi) **Damage Assessment**. Damage assessment is the first step in any DM scenario to determine the requirements of search & rescue, relief and rehabilitation process. The two main categories of disaster assessment is, one short term and another long term. The short term assessment would include all basic needs like rescue, provision of relief, shelter, food, emergency care, potable water supply, sanitation and hygiene maintenance so as to control water and vector borne communicable diseases. On the other hand long term assessment refers to the recoveries which takes little time to stabilize the situation for example, recovery of communications, power supply, transportation needs etc. During natural disaster like landslides, earthquakes, cyclones and floods, the clearance of debris takes more time to rebuild and stabilize the situation. The Long term recovery begins when rehabilitation works starts by way of repair or replacement of roads, bridges, homes, and infrastructures. Therefore, main thrust areas of assessment should be:-

(a) Human and Livestock Losses.

(b) Crop Losses.

(c) Roads, railway track and electrification restoration expenditure.

(d) Requirements of water and food supplements

(e) Requirements of relief camps, temp shelters or repair to the infrastructure including buildings, houses etc

(f) Medical requirements

(g) De-silting and Desalination expenditure of water sources.

(h) Losses to civil amenities.

(xii) **Debris Removal and Crowd Control.** In the event of any major disaster like flash floods and earthquakes, large numbers of personnel are likely get trapped under the debris. The survivors would be anxious and anguish to know the state of missing personnel. There would agitations and concerns resulting in to mob fury. Often, there would be hindrance to the rescue teams, which was seen during Bhuj earthquake as well as in Kashmir. Therefore, debris removal on priority and crowd control are an essential element in any rescue operations.

(xiii) **Vermin Control.** Insects and rodents are the unavoidable pests in any disaster involving water i.e., Cyclones, Floods, Deluge etc. They spread diseases, contaminate foods, and other materials, and can be the source of fear for some. They cannot be totally eliminated, but there are measures which can be instituted to minimize the increase in their population, and their effects on the lives of the displaced communities. Though not a big challenge, yet, Vermin control could be a headache if measures and plans are not in place. Plague in Surat, Gujarat is one of the greatest examples in this category.

(xiv) **Sociological and Psychological After Effects.** Emergency situations due to disaster can be an incredibly stressful, disruptive and for those affected causing mental agony, trauma and stress. Communities can be wiped off, friends and family divided, homes, livelihoods and, of course, lives can be lost and crops can perish. Post disaster, people may experience a range of physical, psychological, emotional or behavioral changes and can impact their ability to cope with the situation. People may experience shock, disbelief, anxiety, fear, anger, shame and guilt in the early days. Often such distress has continued for

years after the physical damages have been restored and reconstructed. Many of them would take years to come back to normalcy. Trauma and grief will put personal, family and community relationships under tremendous pressure. Often, it can lead to an increase in alcohol and drug use, self-harm, violence and abuse. Identification followed by counseling of such affected people often has prevented such prolonged sufferings.

(xv) **Post Disaster Counseling of Traumatized People.** Disasters can substantially impact physical and mental health of the affected population. Major Disasters often leads to trauma and stress of cognitive, behavioral, emotional, physiological, and religious/spiritual beliefs of the survivors for many years. Regardless of how individuals experienced the trauma/disaster, it is during the incubating time that people might experience intense fear, helplessness, and hopelessness that exceed normal coping skills. Many of them ending up with psychiatric disorders. Many a times, Disaster relief workers too encounter considerable stress while providing services to people affected by a disaster and they are exposed to the same risk factors that affect the survivors, hence, It is important to monitor the affected personnel on a regular basis. The medical practitioners and counselors can ease the agony of personnel by series of counseling sessions with the affected personnel. Counseling sessions will also help the personnel to overcome the psychological stress caused by the aftermath of the disasters. Similarly, Orphans need to be provided with culturally sensitive care options, and psycho-social support and legal protection. Female-headed households and disabled persons should equally be provided with psycho-social support, livelihood restoration, and legal protection on matters related to property

and inheritance rights and child custody. Susceptible societies that cannot undertake economic activities immediately shall be required to be supported through targeted social transfers and social protection measures.

(xvi) **Training Regime and Mobilisation of Disaster Response Teams.** The answer to efficient disaster response in future will greatly depend, primarily on the efficacy of the training and regular practice of contingency drills by the Specialised Disaster Response teams. With this objective, a comprehensive Training Regime for Disaster Response was prepared by NDMA/NDRF, identifying the specific disaster response training courses by devising a unified, structured and uniform course modules and accordingly designing appropriate syllabus for these training courses. The scheme of this training helped the State Disaster Response Forces (SDRFs) and other stakeholders immensely. The need for a homogenous structured course module evolved from the fact that if all the NDRF battalions and other 'first responders' undergo the similar training, then the coordination between them would be expedient and well-coordinated at the time of any major disaster, where different NDRF battalions, SDRF battalions and other stakeholders will be working together. Though most of the agencies are largely trained on search and rescue of survivors but equally at ease in any form of disaster that can strike the country, both in natural as well as manmade disasters if common training methodology is adopted. Among the entire spectrum of natural disasters world over, cyclones possibly are the only assured predictable disaster due to the giant strides made in the cyclone forecasting techniques and tools. That is one of the reasons why the Govt of India has invested time and efforts in this segment. Hence, to minimise the loss of lives

and properties in the events of future calamities, the National Cyclone Risk Mitigation Project (NCRMP) was launched by the Ministry of Home Affairs, with support from the World Bank, in various phases, in the cyclone prone coastal States and Union Territories. The NCRMP aims at reducing the vulnerabilities of the cyclone and make people and infrastructure disaster resilient components.

(xvii) **Rehabilitation Process.** The primary responsibility for undertaking rescue, relief and rehabilitation measures in the event of natural disasters is that of the State Governments concerned. The Government at Centre would be supportive in role, in terms of physical and financial resources and complementary in segments such as transport, forecast & warning, inter-State movement of food grains and relief material. Disasters and their dreadful impacts set communities back by decades and leave them vulnerable to physical, social and economic difficulties. This may impede large sections of the affected communities, to come back to normalcy and join the nation's mainstream. While relief work helps communities fulfill their immediate needs, it is important to have a strong recovery and rehabilitation process so as to enable the communities to bounce back better and building their resilience. As part of rehabilitation process, rebuilding homes, schools, toilets, relief centers, makeshift shelters etc are utmost important. Low cost and disaster resilient constructions using robust technology that protects the structures from natural calamities and locally adaptable which produces minimum carbon footprints should be the order of the day. Allocation of adequate funds, identifying the right construction company to undertake rehabilitation work, involvement of local populace & NGOs in

rebuilding process, mobilizing loans, aid & donations and proper monitoring and ensuring timelines of the rehabilitation works are the greatest challenges in any disaster scenario.

(xviii) **Right Flow of Information and Control of Rumor Mongering.** Rumor is typically defined as the spread of unverified or unconfirmed messages. Of late, widespread use of social media has enabled the propagation of messages after disasters at lightning speed. Unfortunately, because the veracity of messages is often difficult to determine in a disaster situation, social media many a times lead to the spread of rumors and fake messages. Post transmission of the rumors, understanding what accounts for message retransmissions in disasters is especially crucial to counter any adverse spread of panic amongst the affected. The retransmission of messages on social media is a simple yet powerful mechanism for message circulation. A study on the use of social media in three major incidents, including the 2008 Mumbai terrorist attack by Dr Onook Oh, of Warwick Business School, Manish Agrawal, of the University of South Florida, and Raghav Rao, of the State University of New York at Buffalo115/116 revealed that Twitter and WhatsApp are emerging as the dominant social reporting tools to report eye-witness accounts and share information on disasters, terrorist attacks and social crises. The online sharing of information by the informal communities may at time transmit exaggerate information which may trigger frenzied alarm. Ideally, official news channels or print/electronic media should

[115] *Report : How to control rumours on social media during a disaster Published by University of Warwick dated 04 April 2014*

[116] *https://www.wbs.ac.uk/news/controlling-rumours-on-social-media-is-crucial-during-a-disaster-or-terrorist-attack/ publ : The University of Warwick, UK*

be roped in to contain misinformation and spread of unrealistic / unhealthy/unwanted spread of rumors. Dr Oh, Assistant Professor of Information Systems, believes authorities and organisations involved in a disaster struck situation need to set up an emergency communication centre to provide speedy, relevant information on the unfolding crisis and to confirm or dispel misinformation circulating on social media. While the upsurge of social media activities have had many positive outcomes, enabling people to contact family members, encouraging blood donations, generous donations of food and cloths and providing eyewitness accounts etc, at the same time, it also caused many rumors to spread causing anxiety and panic amongst the public. Therefore, Emergency response teams need to put in place for prompt emergency communication systems to neutralize/counter the misinformation if any, and provide citizens with timely, localised and correct information through multiple communication channels such as website links, social network websites, print & electronic media, email, text messages or re-tweets. Setting up of an 'emergency communication centre' in the local community can also help in monitoring social media very closely and respond rapidly to unverified or incorrect rumour information. The Disaster Management Act 2005 has a statutory provision for **Directions to media for communication of warnings, etc.,** by which, the National Authority, the State Authority, or a District Authority may recommend to the Government to give direction to any agency 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, and the said means of communication and media as designated shall comply with such direction[117].

(xxiv) **Capacity Building.** It is the same old story every year but a new type of disaster, a new region, different causalities and a new shock; Odisha cyclone 1999, Tsunami 2004, Assam flood 2012, Uttarakhand floods in 2013, and Cyclone Phailin & Helen 2013, Kashmir Floods in 2014, Super cyclones Hudhud 2014, Phetai, Titli & Gaja in 2018, Ockhi 2017, Vardah 2016 or Floods in Kerala, Mumbai, Chennai or Vadodara, whatever be the type of disaster, the end results remained the same; loss of lives, livestock, agriculture and damages to the infrastructure. We have repeatedly encountered disasters striking us, more so in the recent decades and yet every time, it makes us feel vulnerable, clueless and helplessness. Since, risk related with natural disasters cannot be reduced but through maximizing our capacity, we can reduce the adverse effects of these disasters. As per UNDP, **Capacity Building** is a process by which organizations, individuals and societies develop abilities to perform functions, solve problems, set and achieve objectives. As per Sec 2(b) of DM Act 2005 **Capacity Building** includes[118]; (i) identification of existing resources and resources to be acquired or created; (ii) acquiring or creating resources identified under sub-clause (i); and (iii) of the said section, organisation and training of personnel and coordination of such training for effective management of disasters. Capacity development covers strengthening of institutions,

[117] *Ref Sec 67 of DM Act 2005*
[118] *Ref Sec 2(b) of DM Act 2005*

mechanisms, and capacities at all levels of all stakeholders. UNISDR defines 'Capacity Development' for DRR as follows[119]:

"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, but also continuous efforts to develop institutions, political awareness, financial resources, technology systems and the wider enabling environment." (UNISDR, 2016).

(xxv) The primary focus of capacity building is selection and providing training to the people who are capable of planning, coordinating, acting and intervening where necessary. Local teams would fare better and will respond to local disasters quickly, if trained well. Effective management and quick recovery has been a challenge throughout the history of disaster management. Normally, the local community plays an important role in management of disasters. Therefore, capacity building process must be done in a manner that ensures sustainability of the initiatives of the Government. Development of human resources has been one of the core strategies to promote and to enhance the capacity of disaster prone communities. There is an immediate requirement to Validate training procedures, update community based directives, establish institutions, create and strengthen the disaster management organizations and

[119] *National Disaster Management Plan, 2019. A publication of the National Disaster Management Authority, Government of India. November 2019, New Delhi. Para 10.1 ; Pp 339*

modify disaster risk reduction programmes to ensure "Zero tolerance of mitigation process in any situation of disaster in future.

(xxvi) **Destabilization of National Economic Development.** There has been a sharp rise of Economic losses due to natural disasters in the recent past. This has been ascribed mainly to growing population and economic progress in disaster-prone areas. Losses in coming years are expected to increase further due to unrelenting increase in economic exposure and climate changes. This highlights the importance of designing policies that can mitigate the impacts of these disasters on the economy as well as the society. It is estimated that the direct (e.g., property damage) and indirect (e.g., gross domestic product growth, trade and commerce etc) economic impacts of natural disasters will continue to rise in spite of major strides in the science and technological advances. Disasters can have adverse longer-term implications on the economic growth and poverty elevation due to severe negative short-run economic impacts on the growth and fiscal policies. Disasters often influences public finance & expenditure, and can impact domestic revenue, and may lead to increased domestic and/or external borrowing.

(xxvii) **Political Instability.** In India regional politics and parties in power plays a vital role in any DM scenario. These include aspects relating to politics, parties or politicians in the context of disaster management. The political situation in a region may not be supportive of immediate distribution of relief materials or long term reconstruction and the safety and security of the disaster management practitioners can be affected. Deeply rooted political unrest complicated relief and reconstruction in majority of the major disasters in the past is a great case

study. Provision of adequate budget, the adoption of proactive rather than reactive responses, the amendment of conflicting policies and legislations and the definition of clear responsibilities and agendas for various political parties should be the key in the success of any DM scenario.

(xxviii) **Burial of Human Bodies and Animal Carcasses.** Each disaster in its trail leaves behind sufferings, some of which can be alleviated to some extent by relief and rehabilitation measures, but its indelible scars are the loss of precious lives (human, livestock and poultry). The Administration is thus saddled with indomitable task for the retrieval and recovery of the dead followed by their identification to enable handing over of the mortal remains to their next-of-kin. On the contrary, history of disasters is replete with mass burials or mass cremations by the governmental agencies of both the developed and developing countries, without being able to go through the identification process or without preserving the individuality of the deceased, on account of the decomposition process of the dead subject to the environmental factors. Such happenings culminate into social, psychological, emotional, economic, and legal repercussions (financial compensation, property rights, inheritance and issues of remarriage) regarding the legacy of the deceased, thereby exacerbating the damage caused by the disasters. Disposal of dead bodies is a major social obligation of the government wherein positive identification of the deceased for correct and dignified disposal according to religious, cultural, ethnic and psycho-social needs of the affected community is very important. In view of the response to mass disposal of the dead in the past by the administrations, it became necessary for the NDMA to formulate the National Guidelines to

formalise the standard procedures for prompt and appropriate management of dead bodies and animal carcasses in the aftermath of disasters. Under the ambit of Incident Response System, the procedure as regards the management of the dead would be incorporated in the National, State and District Disaster Management Plans.

(xxix) **Application of Science and Technology.** Over the last 20 years, Science & Technology has brought a deeper understanding of how the disasters are created and how they can be managed. With robust information on hazard patters, exposure data on people, capital assets & economic activity and much greater understanding of fragility or vulnerability of understanding the subject on DM. with these developments, it is now possible to not only forecast disaster events but can also anticipate their effect with a high level of confidence even before its impact on the disaster site. Notwithstanding the promising developments in the field of science and technology, there are the ***six major challenges*** worth highlighting.

(a) ***Firstly, the time lags between the availability of scientific and technological capability and its on-ground application.*** For instance, we hear about products, tools and technologies developed by the DRDOs, universities and various regional research laboratories that may be useful in the DM scenario, but seldom are these available to the civilian environment? By the time it reaches the environment, the technology becomes redundant.

(b) ***Second challenge would be on technological developmental side.*** It is very difficult to ensure the research is focused on the developing

methodologies that are tailor made to a specific disaster. The shift from a Disaster Management to a Disaster Risk Management would be a herculean task. Therefore, there is a requirement to process ***"out of box innovations"*** and develop and explore new technologies.

(c) ***Third challenge is on the Data collection and its access.*** While recording of the voluminous data on major disasters is in place but how about collection of data on minor disasters says fire, building collapses, boat capsizes, breach of canals lakes & dams, landslides, avalanches, collapse of bridges etc? Many a times these go un-noticed and thus loose valuable inputs on the disaster risk mitigation issues. Similarly, most of the Data sets are in the hands – or, rather, on the servers – of private corporations, institutions, researchers or defence organisations and as on date neither comprehensive framework, legal or otherwise, for data sharing exists nor integration of the same into policy making and programming with official agencies exists.

(d) ***Fourthly,*** the climate change scenario and its serious fallouts with unpredictable weather pattern hold terrible repercussions, concerning vulnerabilities, mitigation, crisis response, emergency & disaster preparedness and warning. In spite of tremendous progress in the field of meteorology, the reliability and degree of accuracy continues to be a major concern and challenge to the forecasters. While response mechanism really calls for interference and involvement of government machinery at all levels including army, it will be a better idea to have a core of trained personnel at local, district, State and national levels, as

part of a multiple tier system of disaster preparedness and emergency handling as well as awareness creation and timely warning to the local populace.

(e) ***Fifthly,*** majority of the DM participants, are unaware and often ignorant of the usage of scientific tools and interpretation of scientific codes and methodologies. This is resulting in to laxity and encouraging slackness. For example, very few are aware of the importance of decision sciences and Developments in the field of ***Disruptive Technologies*** – such as artificial intelligence, the Internet of Things, Data Sciences including Big Data and innovations in the field of robotics and drone technologies though remain largely experimental, yet are transforming many fields, including disaster risk reduction and management. The biggest dilemma to the Government is how to sensitize the grassroots' functionaries' in this field.

(f) **Sixthly**, limitations of science and technology in the prediction of disasters. Many of the developments, innovations and improvements in this field are either on the drawing boards or at the experimental stages. The tools and advances, though showing great promises and possibilities but they need to be verified on real time basis and necessitates validation. For example we keep talking about the disruptive technologies, but how many of them are implementable? Although artificial intelligence, for instance is advanced enough to help in various applications, but the limitations of **AI** are preventing the use of the technology in real-world applications. **AI**, although can compete with

humans in the volume and speed of operations, but not in the quality of prediction. Yet, another reason with **AI** is that the data is based on past records of natural disasters. Therefore, **AI**-powered applications cannot process the changing trends and enormities of natural disasters such as cyclones, floods and earthquakes. Hence, it will be a challenge to introduce the effect of climate change on natural disasters in the existing **AI**-powered envelop, as **AI** is trained using archived records. While the system can predict the climate change but it cannot predict the effects of climate change where interface of humans is required. Therefore, it is difficult for **AI** to predict long or short term trends of various disasters that are influenced by climate change. In the past, there have been instances where **AI** made mistakes, primarily due to human interface; as any flawed data fed by humans to the system can lead to errors and omissions, leading to erroneous **AI** results. Additionally, looking at the previous trends there will be a tendency to be too dependent on **AI**. One of the major limitations of science and technology in the prediction of disasters is tolerance limits and errors in judgment. For instance, if any system erroneously predicts the location of the aftershock followed by an earthquake, countless lives will be lost as people will be caught unaware. Similar is the case of cyclones and flood predictions. If the landfall is incorrect or flow of flood shows an error, imagine the catastrophe that will lead to? Too much reliance on systems is not a good practice; adequate margins for errors must be allowed and DM stakeholders/policy makers must plan the events keeping the tolerance

limits of the technological tools. Hence, scientists still have to carry out multiple tests to make the technology reliable, applicable and implementable.

(xxx) **Assessment of Relief Requirements.** Relief in DM scenario means, provision of essential, appropriate and timely humanitarian assistance to those affected by a **disaster.** This is based on an initial and rapid assessment of needs designed to contribute effectively and promptly to their speedy **recovery process**. **Disaster relief** can also be referred as the process of responding to a catastrophic situation, providing humanitarian aid to persons and communities who have suffered from some form of disaster. The emergency management is continuous process and would be effective only when all the stakeholders involve themselves towards reducing the impact of the disaster hazards. Effective Emergency management would be effective if involvement from all levels of government and non-government is ensured.

7.4 Loss in terms of private, community, public assets along with losses to human lives, livestock etc would be phenomenal in any DM scenario. The greatest challenge under these circumstances is how to tackle this and mitigate the losses and tackle the challenges involved in the least possible time. There is an immediate requirement to chalk out multi-prong strategy in a pro-active manner than reactive manner in any form of Disaster. The Disaster Management Act 2005 clearly explains the role and functions of various agencies. It is also a tool, legally enacted to bring in a sense of accountability and responsibility amongst the stakeholders. This act also has a provision to deploy Naval, Army and Air Forces and other Armed Forces of the Union or CPMFs or any other civilian personnel as may be required to tackle the disasters.

CHAPTER-VIII

ROLE OF ARMED FORCES IN DISASTER MANAGEMENT

The "Organisational strength of the Armed Forces, their high sense of discipline, the enormous manpower at their disposal and their excellent human resource Management makes them an extremely useful tool in providing disaster relief'

Report of US Government Study on Disaster Response in India

8.1 Disaster management is a continuous and cohesive process involving many stakeholders working in unison to prevent, mitigate, prepare for, and respond to disaster and reconstruction post disaster. It is established fact that no single organization can handle a disaster situation of any scale singlehandedly. It is the joint responsibility of diverse groups of stakeholders, namely, various ministries, departments and boards of union, State and local government bodies, private sector, civil society, Non- Governmental Organizations (NGOs), Armed Forces, Central Armed Police Forces (CAPF), National Disaster Response Force (NDRF) and international institutions etc., and everyone plays a different role in this process. While, some stakeholders may have a leading role in DM, others play a supportive role in this process. Amongst the many different groups of stakeholders in the disaster management scenario, "***The Armed Forces" plays a significant role in almost all the phases of Disaster Management"***.

8.2 Natural disasters, which struck India in the past, yielded a wealth of information and widened our horizon besides opening a plethora of avenues on the mitigation aspects in the field of Disaster Management. The country has integrated State administrative machinery with lot of national stakeholders for the management of disasters at the National, State, District, and Sub-District levels. The State Governments concerned are basically responsible to undertaking rescue, relief, and

rehabilitation measures in the event of any disaster. The Central Government supplements the efforts of the State by providing financial and logistic support, if required. If the situation so warrants, the ***Indian Armed Forces*** too would be called upon under ***"Aid to Civil"*** clause, to intervene and take on specific tasks like maintenance of law and order, maintenance of essential services, disaster relief and other types of assistance when called upon to do so. The Indian Armed Forces have always done an admirable job, when called to aid civil authorities during natural calamities. Though, as per the policy in vogue, they would be called only a last resort when all possible options are closed however, in practice, on account of their organizational strengths, discipline and superior reaction capabilities, the Armed Forces have often been called by the Government machinery as ***First Responders*** in every major disaster that struck the country in the past, Historically, the Armed Forces have played a major support role in contingencies such as **Restoration of Communications**, **Search and Rescue** operations, **Health** and **Medical Facilities**, **Transportation & Heavy lift by the Air Arm, Alternate Power supply, Food** and **Civil Supplies**, provision of water and food supplies and **Public Works** & **Engineering**, especially in the immediate aftermath of a disaster. Government and the public invest tremendous faith in the Armed Forces and believe that all emergencies and crises can be single handled by the Armed Forces effectively. That notwithstanding, there appears to be a growing concern in some quarters, within the '***Defence fraternity'***, that of late, the Armed Forces are over-indulging in ***aid to civil*** authority. There are different views on this subject; one recommends reducing our response and control over-enthusiasm; the other recommends a larger, proactive and more participative role and third and more contentious is how best the Armed Forces

are placed within the disaster management cycle and to what extent the military model is appropriate?

8.3 Furthermore, the Indian Armed Forces have also rendered disaster aid to a number of friendly foreign countries in the past, adding yet another dimension to the international disaster response. A number of neighboring countries look up to India on many a front, especially when struck by a major calamity. With growing regional and global cooperation in disaster reduction and response, the Indian Armed Forces are playing a vital role befitting India's emerging status of a regional power.

8.4 As per the National Policy on Disaster Management 2009, the Armed Forces, is also one of the first responders and would be called upon to assist the civil administration, when the situation is alarming and beyond their capability to handle. The Armed Forces constitute a substantial and powerful body available with the GoI for disaster response and relief. The Indian Army, by virtue of its organisational strength, motivation, discipline and operational preparedness, has always risen to the occasion, earning the appreciation of the environment for its singular contribution in the field of SAR, debris removal, emergency construction of bridges and culverts, evacuation, demolition of effected or damaged structures, emergency medical aid etc., while the Air Force and Navies involves in airlift of medium to heavy Rehab material, causality evacuation and food & essential commodities distribution. Navy specializes in rescue of marooned and water trapped personnel and provision of potable water supply from their war ships.

8.5 **Command and Control.** At the national level, CIDS to the COSC was included in the NEC (with the setting up of CDS, there could be some major changes envisaged at the apex level in the field of DM process). At State and at the district

level, the local **Military Commander** has been included in the Executive Committees for better coordination and cohesion. The **primary role** of the Armed Forces is to preserve national interest by safeguarding the territorial integrity of the nation against external threats, as well as the nation's strategic interest in the region. Its **secondary role however, is "*Aid to Civil Authority*" which is a constitutional obligation, although it is an instrument of last resort.** Assisting civil authorities in handling internal threats, maintenance of essential **services,** as also to assist the Central Government or States during any disasters is an important charter of the forces. The Armed Forces provide a speedy and efficient response when called upon while dealing with a disaster situation that is beyond the ability of civil administration. They are also capable of providing emergency health care (As was seen during Bhuj earthquake, Kashmir earthquake and Tsunami 2004, when the entire civil Medical administration collapsed) and relief measures, particularly in search, rescue, evacuation, shelter for victims and damage assessment. Therefore, the Government often falls back on the Armed Force during emergencies. The Army's presence in under-developed areas along our borders also helps in contributing to the relief endeavors where the governments` relief mechanism and sources are frail.

8.6 The scope of deployment of military resources and capabilities is very broad and ranges from individual specialized pieces of equipment such as portable water purification systems, to small scale specialized capabilities such as Chemical Biological Radiation Nuclear (CBRN) response, strategic planning, coordination and logistics capabilities for large and complex situations. Armed Forces may also be called upon to provide the following types of assistance:

(i) **Provision of Infrastructure for Command and Control of an Organisation towards Relief.** This would involve provision of emergency communications and making available technical, medical and other specialist manpower at the disposal of Central/State agencies.

(ii) **Restoration and Maintenance of Electricity & Communication lines.** Restoration of telecommunication/ field-communication becomes an important task of the Armed Forces in flood affected and cyclone hit areas. While the personnel of the Signal Corps of the Indian Army undertake this responsibility and urgently rebuild the communication system, the Corps of Engineers of the Armed Forces undertake emergency repair and reconstruction work of the roads and bridges damaged by floods, cyclones, tidal waves and help restore effective and workable communication system.

(iii) **Medical and Sanitation Services.** Management of Emergency Medical care, sanitation and dealing with Trauma & Disability cases is the primary task of Military doctors during any disaster. Members of Army Medical Corps immediately start providing all kinds of emergency and general medical services including vaccines and setting up of sanitation facilities through active participation, wherever possible to the affected people.

(iv) Logistic support for **transportation of relief material** and manpower especially from the NDRF.

(v) Setting up and running of **relief camps**.

(vi) Construction and repair of temporary **roads** and **bridge**s to enable to relief term/material to reach effected areas.

(vii) Repair, maintenance and running of **essential services** especially in the

initial stage of disaster relief and aviation support for transporting relief and medical emergencies.

(viii) Assist in search & rescue, debris clearance and **evacuation** of people to safe place before, during and after the Disaster.

(ix) Stage management and handling of **International Relief**, if requested by the Civil Administration.

(x) The Armed Forces will participate in imparting training to trainers and DM managers, especially in heli-borne operations & insertions, high-altitude & mountainous rescue, waterman ship, training of paramedics and CBRN aspects, in which the Armed Forces are authority, with no civilian institute in reckoning.

Why the Armed Forces Deployment in the DM Scenario?

8.7 The following attributes make the Armed Forces a potent instrument for disaster relief :-

(i) The involvement of the Armed Forces in a disaster situation is on the rise primarily due to overwhelming scale and reach of the disasters which surpassed civilian Disaster Management capabilities and resources.

(ii) It is aptly poised for quick response and with great mobility, self-contained and composite task forces capable to move to any part of the country, even overseas, in conjunction with the Navy and Air Force in the shortest possible time.

(iii) It is structured, organised and managed to provide support for a full range of public relief services.

(iv) It's a disciplined and an obedient force with a very high motivation levels.

(v) They are self-reliant, versatile to perform in any adverse conditions physical and environmental both, autonomous and capable of taking independent decisions.

(vi) Huge resources, both human and material are available at the disposal of the Armed Forces.

Specialized and Unique Capabilities of the Armed Forces

8.8 Forces per se, are a war waging machinery and not trained on disaster management nuances. However, with their roles and training in certain areas, they become much more potent in tackling the issues which are very relevant in the field of disasters. The Armed Forces provide a unique set of relevant skills, expertise and capabilities. Civilians generally found wanting in these areas. Some of the examples of such capabilities with respect to the Armed Forces are appended below:-

(i) **Indian Air Force.** IAF has huge inventory of Helicopters and light to medium to heavy lift transport aircraft. Though not of the same size, Army and Navy too have Air arm under their disposal. Their primary role is to carry troops, artillery, armament and other essential war waging equipment during peace as well as war. Helicopters and Transport aircraft are also used for various war maneuvers like winching or slithering ops, Para drops, SAR, under-sling ops, air drop of cargo etc. The same expertise can also be used in a disaster situation like, for air drop of relief material, food and water packets etc to remote locations, marooned and water locked situation like during floods or cyclones. Similarly, stranded people can be pulled out from the trapped areas thru winching ops and can be evacuated to safer areas and injured to various medical centers. Helicopters can be used effectively in SAR ops and surveillance of the disaster

struck areas for assessment of the damages and requirement of relief to the affected areas.

(ii) **Indian Army.** Indian Army, by virtue of their sheer size, dedication and discipline is capable of handling any situation including complex disasters. The troops are definitely not trained in DM duties yet their experience, training and nature of their job makes them very unique to handle the disaster cases too in an efficient and organised way. Some of the Arms and Services of the Army that can be effectively dovetailed to the DM role are given in the succeeding paragraphs.

(iii) **Army Supply Corps.** As the name suggests, this Corps handles huge inventory of rations, both dry and fresh. Their inventory management, accounting and supply procedure are impeccable. They also have a transport pool with huge inventory of vehicles and Pioneer Company, which is a combat arm comprising of loaders and manual laborers for carting the material loads. With their vast network coupled with trained manpower can be very effective in a DM scenario. Government can look up to their stock/inventory to augment the emergency supplies during disasters on emergency transfer basis. They also have a large numbers of Mules to transport material to hilly and inhospitable terrain, which can be of immense help in high altitude and mountainous / snowy terrain disasters.

(iv) **Corps of Engineers.** The **Corps of Engineers** of the India Army has an enviable history dating back to the 18th century. This Corps alone can single handedly manage any type of Disaster. Not only they have the relevant expertise but also have huge inventory of specialized equipment to handle the emergency.

For example the Corps of Engrs have the following specialist divisions under their command.

(a) Bridge Engg Section is capable of undertaking construction, repair of bridges, laying of temporary columns, baily bridges, ropeways etc.

(b) Civil Engg Section, including Barrack and Repair (B&R) Sections are capable of construction of buildings, carryout civil works to any damaged buildings, culverts, roads, septic tanks, STPs, Over Head and Underground water tanks, bunds etc. They also specialize in laying water pipes and supply of emergency water source.

(c) Electrical & Mechanical Engg Section (E&M) is capable of undertaking all the electrical and mechanical works of any installation be it to the HT and LT transmission cables, generator sets, power generation units, provision of alternate electric supplies, maintenance and repair of transformers etc.

(d) They also have a huge inventory of following equipment:-

(aa) Plant and machinery like graders, dozers, excavator, loaders, cranes and air compressors

(ab) Boats, outboard motors and aerial cableway/ropeway systems

(ac) Diesel and kerosene Generator sets

(ad) Water Supply Equipment like Pump sets, rubberized fabric tanks, water purification sets, water tank reservoirs

(ae) Floating and dry bridges, called Sarvatra equipment

(v) **Military Engr Service (MES).** MES is a service provider for initiation, repair and maintenance of works services both in the field of B&R and E&M

works for all the three services. It's a sub-branch of Corp of Engrs and majority of the units of the Armed Forces are covered by this organisation. MES can also undertake Deposit for non-governmental agencies, Cantonment boards and private persons. MES has enormous inventory of repair material, cement, steel, bricks, electrical material etc to undertake any major disruption of essential services. They also have running contracts for various services for undertaking any emergency breakdown. Their services can be effectively utilized in any disaster situation.

(vi) **Army Ordinance Corps (AOC).** This Corps is responsible for the research, design and development of engineer equipment of ordnance origin, demolition explosives, mines and mine detection equipment. All these can be effectively used in any form disaster.

(vii) **Station Work Shops.** Workshops have variety of experience in handling almost every type of equipment, be it signal Eqpt, vehicles, communication Eqpt or computers. For restoration of any kind vehicles or communication Eqpt, this organisation can be relied on during emergencies.

(viii) **Border Roads Organisation (BRO)[120].** BRO constructs and maintains strategic roads that serve the border areas of the country, India. Though under the MoD, It is staffed with a combination of Border Roads Engineering Service Officers, Administrative Officers, Medical Officers and Hindi Officers from the General Reserve Engineer Force (GREF) and officers from the Corps of Engineers, Electrical and Mechanical Engineers, ASC Officers and Officers of

[120] *Standing committee on Defence (2014-2015) (sixteenth Lok Sabha) MoD Demands for grants (2015-2016) Civil expenditure of the MoD And Capital outlay on Defence services Presented to Lok Sabha on 27.04.2015 Laid in Rajya Sabha on 27.04.2015; Published under the aegis of Lok Sabha Secretariat New Delhi April, 2015*

Military Police and Personnel of the Indian Army. The organisation develops and maintains arterial roads on the borders of India. Apart from road construction, the BRO is also involved in the construction of a tunnel at the Rohtang pass. BRO's activities have also helped to accelerate the economic development of the North and North-Eastern Border States of India. The road construction teams have to deal with harsh climatic conditions. BRO faces environment challenges like the icy Himalayan mountaintops, high altitude mountainous terrains, the marshy areas of West Bengal and North Eastern States and the deserts in Rajasthan. The BRO builds and maintains roads at high altitude; some of the BRO roads are built as high as 5,608 meters (18,399 ft.) above mean sea level. The expertise of this organisation can be effectively used to re-open the roads and open other transport links.

(ix) **Infantry Regiments.** Most of the troops are foot soldiers; who are healthy, well disciplined, with a very high integrity and most importantly "Never say No attitude". These troops can be deployed for variety of jobs starting from debris clearance, cutting of girders, demolition of dilapidated buildings, search and rescue, burial of dead people and animals, transportation and distribution of relief material, shifting of people to various relief shelters etc are some of the key areas where the infantry troops can be deployed. Presence of these personnel will boost the confidence of other agencies are involved in Disaster Management activities.

(x) **Corp of Signals[121].** The Corps of Signals is well prepared to exploit the state-of-art modern communication techniques for meeting the requirements of

[121] *https://www.indianarmy.nic.in/*

the Indian Army in the 21st century. Some of the areas where the Corps is already in the process of exploiting are the Cellular Radio (both GSM & CDMA), WLL, mobile trunked radio including amateur radio, mobile satellite systems, and optical fiber communication and so on. Advanced data transmission techniques such as PDH and SDH are also being used. This Corps has developed certain capabilities indigenously, namely:-

(a) Army Static Switched Communication Network (ASCON)

(b) Troposcatter Communication Systems

(c) Satellite Communication (SATCOM)

(d) Strategic Broadband Satellite Network

(e) Computer Data Networks

(f) Static Peace Communications

(g) Strategic Alliance with BSNL

(h) Network for Spectrum

(i) Central Data Centre

Note: *These are some of the systems that are being developed by the Corps of Signals that have applications both in the Civil and the Armed Forces as well. Should the civilian link fails or destroyed or damaged, the State disaster response teams can rely on the Corps of Signal's expertise in restoration of communication links.*

(xi) **Remount and Veterinary Corps (RVC).** RVC is one of the oldest Corps of the Indian Army. This Corps has also been involved in providing veterinary assistance to rural areas in Jammu and Kashmir and North East India under Project Sadbhavana. The corps has also been associated with passing on their expertise and training veterinary students of the Sher-e-Kashmir University of

Agricultural and veterinary Sciences of Jammu. RVC has trained Dogs under them and they can be effectively used in the case of people who are trapped under debris, marooned in water logged areas, sniff explosives or unexploded bombs/explosives. Dogs were extensively used both during Bhuj earthquake and J&K earthquakes as well as during infamous Taj Hotel Seize in Mumbai. RVC has also provided assistance as part of the Indian contingent in many UN missions across the world.

(xii) **Indian Navy & Indian Coast Guard.** Navy is primarily a water borne platform with huge inventory of ships and fairly decent numbers of Helicopters and transport aircraft. Navy is capable of rescuing stranded people, marooned people from water locked areas and areas affected by deluge or cyclones or floods. They have huge inventory of inflated boats, mechanized dinghies in the form of Geminis, speed boats that can be used to reach to the stranded people from water logged areas. The maneuvers that are used to search, rescue, evacuation, transfers etc, can be successfully used in the event of any disaster especially during floods, cyclones and Tsunamis to reach to the disaster stricken communities. Their Air element too can be utilised effectively to evacuate people, search and rescue in relief operations, especially along the coastal areas. One of the unique features of the Naval and Coast guard's ships is the ability to carry huge quantities of water and purification of sea water through their onboard inbuilt RO filtration plants. In the past the ships of both arms, have supplied potable drinking water to the affected areas during various calamities.

8.9 The invaluable training and practice of war maneuvers routinely enabled the Armed Forces to face any challenge be it armed conflict, rescue of stranded personnel,

evacuation of injured or disaster affected contingencies. While there is no doubt about the uniqueness of the expertise of the Armed Forces in lifesaving tasks, what is more interesting is the role of their medical and paramedical ability to attend to the injured swiftly, without wasting any time in providing the lifesaving medical care. As was seen during the Bhuj and J&K earthquakes, where number of injured treated by the military doctors outnumbered the ones attended by the civilian is a point in issue.

8.10 While the Armed Forces might have expertise and wherewithal for Disaster Management, but remember that the National security and war-fighting capability, not the provision of Disaster or emergency management response, are the primary task for the Armed Forces, hence, Military assistance will complement and not be a substitute for civil participation in civil defense operations. Military planners and civil authority must recognize that civil resources will be the first resources used to support civil requirements with military resources being used only as supplement to the civil resources, and not the other way round.

8.11 **High Power Committee (HPC) Report and Armed Forces' Envisaged Role, Tasks and Commitments.** The **HPC** Report of 2001, opines that the *"**The Indian Armed Forces are one of the most dedicated and professional organisations with a rich tradition of being involved in the socio-developmental roles in nation building. Their services should be utilised as the last resort and be called upon to intervene and take on specific tasks only when the situation is beyond the coping capability of the civil administration,"*** and further recommendations that:-

(i) Armed Forces must be involved in planning and prep process for coping with disasters.

(ii) State and District plans should incorporate the roles expected from

Armed Forces so as to make their deployment smooth and quick.

(iii) Armed Forces Training programme should include disaster specific training to the persons for Emergency Support Functions (ESFs) both for personnel as well as to the trainers.

(iv) Vast pool of trained ex-servicemen is ought to be included in the national disaster Management structure and assigned appropriate role in the response to disasters.

Role of Armed Forces in the Restructured National Structure for Disaster Management.

8.12 Armed Forces have been the ***primary responders*** of disaster response process in the past. In the last few years, fair amount of efforts have been made in restructuring our disaster management mechanism and better coordination amongst ministries & departments. The current disaster management frame work is attempting to evolve an elaborate civilian frame work under Min of Home and State Govts wherein the Armed Forces have been recognized as primary responders in only one of the fifteen disciplines i.e., Search & Rescue.

8.13 While the strengthening of disaster management frame work is a highly desirable step, it needs to be clearly understood that in majority of situations, the civil disaster response mechanism and administration in affected area itself becomes the victim of the calamity and require a reasonable reaction time in re-organizing and responding in the face of the adversity. It needs to be understood that on account of peculiar organizational strengths and efficiency, Armed Forces would continue to be the primary respondent in future calamities, although it is highly likely that civil administration may be able to organize much more rapidly and relieve Armed

Forces in earlier timeframes than experienced in the past. **Sequential deployment of rescue and relief resources or a graduated response by various bodies to emergencies is burdened with the dangers of delay, and the situation may go beyond control.** Ideally, a quick and comprehensive assessment of the required response to a disaster or impending disaster is needed. This will facilitate deployment of the necessary resources, including the Armed Forces elements, without loss of time, to limit the damage and losses to a minimum.

8.14 The disaster management framework and plans are conspicuous by absence of clear cut strategy and role of Armed Forces are expected to play (Even National Policy of Disaster Management 2009 dedicates only one Para on the role of Armed Forces). While, the framework recognizes primary role of Armed Forces in Search and Rescue and secondary role in communication, transportations, maintenance of law and order, relief and engineering; however no effort has been made to outline modalities and establish suitable linkages in this regard. While establishing self-reliant framework is a welcome step, stark realities need recognition. Armed Forces have played a key role in disaster relief in the past and would continue to shoulder the responsibilities in the future.

8.15 **What is the Obligation of Armed Forces When Requisitioned by Civil Administration?** There appears to be dichotomy in the understanding on the part of a few field commanders, whether every requisition for ***aid to civil*** authority has to be complied with? Discretion, to respond, whether or not clarification is required from higher formation has to be exercised by the commander on the ground depending upon the gravity of the situation. Requisition from the civil administration for assistance in case of a disaster generally complied with, due to very little reaction time. However,

routine requisitions such as evacuation of a civilian trapped in a hole, recovery of a dead body from waters and such requests, which do not fall within the ambit of "***disaster rescue and relief***" may be declined or executed only after due clearance from the higher formation. In cases of any ambiguity, unit / formation commanders may advise the local administration to route their request through the MHA and MoD channels. Alternatively, in case constrain of time, and then the higher formation may be contacted telephonically for appropriate clearances. At the same time it is important to impress upon the civil administration to timely inform them regarding winding up operations too, as any deployment of the Armed Forces beyond 10 days requires MoD sanction. Another, important aspect the civil administration has to keep in mind the methodology of deployment of forces, which should be left at the discretions of the field commanders. Good mutual understanding between the civil administration and the local Armed Forces units / formations will go a long way in ensuring fair and judicious utilisation of the Armed Force's resources, capacities and expertise in disaster management.

8.16 **Humanitarian Assistance and Disaster Relief[122].** The Indian subcontinent is home to 70% of the world's natural disasters like floods, droughts, cyclones, earthquakes etc in addition to man-made disasters like global warming, wildfires, epidemics, etc. The impact of these disasters is more predominant in underdeveloped, boarder areas and remote areas, where facilities to handle such calamities do not exist. Relief needs to be provided to the affected population during disasters or distress situations by rendering necessary assistance keeping in mind the following:-

[122] *Joint Doctrine of the Indian Armed Forces, published by HQ IDS, MoD*

(i) Assistance under the humanitarian umbrella should not jeopardize the National Security Interests and therefore the operational readiness of the Armed Forces performing such missions should be kept in mind.

(ii) The readiness will entail provisioning of medical care, basic sanitation facilities, repair of public amenities and facilities, education, training and technical assistance.

(iii) This function will also be performed by the Armed Forces Medical Services, in close coordination with the National Disaster Response Force. It may be utilised in an international situation, as also to address the needs of the Indian diaspora abroad.

8.17 **What are the Reasons for Increased Deployment of Armed Forces in Disaster Management?** India is highly vulnerable to disasters due to rapid climate changes and collateral damages too are on increase because of densely populated areas. In spite of rapid increased in role, responsibility and strength of National Disaster Response Force and State Disaster Response Forces, the Armed Forces will continue to get engaged in rescue and relief ops due to the triggering of disasters of unusual magnitude and colossal damage it is bringing with it. Many a times, the Armed Forces may have to react even before NDRF/SDRF teams are positioned on account of their proximity to the disaster struck area, especially at remote places, inaccessible places and boarder areas. A living proof being the deployment of Navy and Air Force during Tsunami in Andaman and during Kashmir earthquake by the Army and the Air Force teams. Another vital feature is the public faith in the forces and resultant pressure on the administration to call the Armed Forces to provide assistance to the affected disaster victims. Another reason for the deployment of the Armed Forces in the very first instance is the public turmoil, lack

of confidence in civil apparatus, growing political sensitivities and ever increasing media glare. Government or political establishment would not take a chance; hence, deployment of the Armed Forces in such scenarios becomes a safe option. Yet another option necessitating deployment in disaster response could be in case of mass casualty events, especially in the case of Tsunamis and earthquake, where the reaction time is minimal and collateral damage is highest. Any augmentation in relief and rescue ops is a welcome boon in the disaster response.

8.18 **Is Timely Deployment of Armed Forces Effective in Disaster Rescue and Relief Operations?** ***First responders – last resort***, is the basic principle for deployment of the Armed Forces in disaster rescue and relief operations: first responder, is the first response by the forces in the close vicinity of the disaster location on their own, as was the instance in the earthquake in Gujarat in 2001, Tsunami 2004 and 2005 Kashmir earthquake. There has been a noticeable enhancement in coordination between the Armed Forces formations and local civil administration bodies in the last few years. But, much more is desired to plug gaps and achieve the desired synergy between these agencies to optimize for better results. Some of the important points that needs better appreciation are as follows:-

(i) District / State civil administrations must know their strengths and weaknesses in coping with the disasters within their area of influence. Analysis of these can highlight the weak areas and weak links in the disaster management arrangements.

(ii) Periodical mock exercises' and joint training need to be carried out all the stakeholders field for "scenario building", review operational preparedness and build capabilities to tackle contingencies and emergencies. This will also facilitate

the planning of identifying the areas, topography, bottlenecks, logjams that would require assistance of Armed Forces.

(iii) Timely intimation of forecasted disaster if any, and the type of assistance envisaged from the local Armed Forces units will go a long way for timely assistance from them. Thus, sharing of information with Armed Forces is an important aspect that the civil administration should keep in mind.

(iv) The civil administration must have the contact details of commanders and staff officers of local Armed Forces units/formations and vise-versa for effective coordination in times of emergency. Periodical review and regular Civil-Military liaison meetings therefore should be held.

8.19 This list of measures is not exhaustive and many more measures can add value to own joint disaster response. These exercises will help review the procedures, communications, and develop mutual faith and rapport. While some of the States like Gujarat, Tamil Nadu, Odisha, Andhra Pradesh Karnataka, West Bengal and Delhi have addressed most of the above mentioned issues, there is enough scope for improvement in most of the other States as well.

8.20 **Co-ordination Mechanism.** The restructured national disaster management mechanism, depicting corresponding linkages and status of Armed Forces in the overall hierarchy, is depicted at figure below[123].

[123] *Source: Lt Gen Madan Gopal DGMO at International Seminar on Disaster Management: 06-08 Dec 2005*

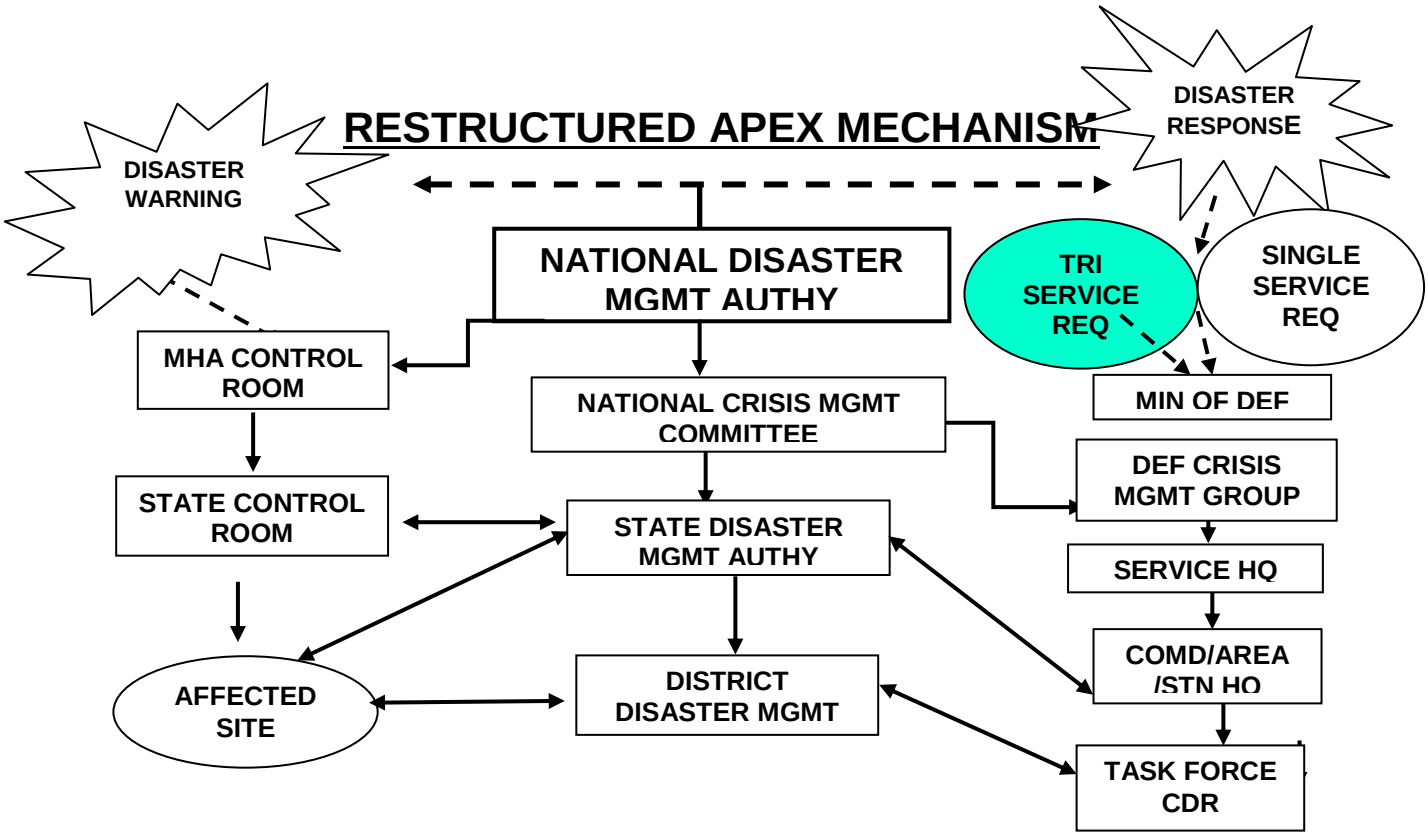


Fig 8.1

Restructured National Disaster Management Mechanism

8.21 **Should the Armed Forces be given Larger Role in the Management of Disasters?** The role of the Armed Forces is presently confined to augmentation of search, rescue and relief operations as part of the first response. Armed Forces have had no functional role in prevention and mitigation of disasters (pre-disaster) or long-term rehabilitation measures (post-disaster) in the past. Now, in the changed scenario, where prevention of disasters and mitigation of adverse effects of disasters is priority, would include vulnerability and risk assessment, risk reduction and capacity building. This is keeping in mind that the objective of achieving resilience to disasters is more important than post-disaster relief and rehabilitation. In this scenario, should the Armed Forces be given a larger role? Probably yes, as the larger role is perhaps influenced and motivated by the models followed in many western countries. For instance, in the US, the National Response Plan applies a functional approach that groups the capabilities of federal departments, agencies and the American Red Cross into Emergency Support Functions (ESFs) to provide for planning, support, resources, programme implementation, and

emergency services that are most likely to be required during Incidents of National Significance. The Department of Defence in the USA is involved in many primary and support functions[124]. Seeking such a larger and proactive role for the Armed Forces in India, in any of the other spheres like prevention, mitigation and long-term rehabilitation of disaster management may not be rationally justifiable as these basically fall in the realm of the civil administration as an overall function of governance. In my opinion ***the Armed Forces should continue to perform their conventional role of rescue and relief in support of the civil administration***. Any deviation from past or additional role to the Armed Forces may jeopardize their very purpose of existence. Though opponents of this school of thought are demanding a more proactive role to the Armed Forces. In this era of super-specialization and domain expertise, organisations need to focus on the core competencies and shed the obsession with learning skills that are otherwise readily available with other establishments; hence there is a need to exercise caution. During this process, another dimension has emerged which is ***Outsourcing***. This can be achieved through various new organisations such as National Disaster Response Force at the national level and composite task forces with armed police, fire services, engineers and medical teams being raised at State level. These organisations can be provided with specialist training, as discussed in the previous paragraphs. The Armed Forces can tremendously contribute towards mitigation process to restrict and prevent loss of human lives and damage to property, because of their training and combat preparedness.. Assistance in terms skill development and training can also be offered to paramilitary forces, civil defence teams, home guards and the teams from the corporate sector and NGOs. Training in some of the aspects like slithering and counter-measures with respect to CBRN related disasters is already being imparted to a select few. Support in terms of offering equipment, advice and other resources have been rendered in the past and will continue to be provided in the future too. The Indian Armed Forces do not need legislation to offer aid, that too humanitarian in nature, during disasters, but of course, the planning at the national level must include the scope and limitation of the assistance for effective coordination at grassroots level.

8.22 **Armed Forces in their Role in International Disaster Response.** As a part of regional cooperation, the Indian Armed Forces in the past were also involved in disaster

[124] *Source: https://www.nwo.usace.army.mil/pdc/home*

response at the international level, especially in South Asia region. With increased regional influence and global cooperation on the issue, many countries, especially South Asia countries and countries from Africa look up to India as big brother for assistance during disasters and major calamities. GoI, through NITI Ayog has created a specialized humanitarian assistance and disaster relief agency under the joint aegis of the Ministry of External Affairs and National Security Council Secretariat to deliver humanitarian assistance in the under developed countries. Some of the recent instances when the Indian Armed Forces have rendered aid to various countries in response and relief capacity are[125]:-

(i) **Katrina Disaster.** In the aftermath of Hurricane Katrina, approximately 25 tons of **disaster** relief supplies were dispatched in an Air Force IL- 76 airplane to the USA on September 9, 2005.

(ii) **Philippines Mudslide.** In the aftermath of widespread mudslides in Leyte (East Philippines) on February 17, 2006, approximately 30 tons of disaster relief supplies, including medicines, were dispatched to Philippines on 22 Feb 2006.

(iii) **Indonesia Earthquake.** In the aftermath of the major earthquake in Jakarta on 27 May 06, approximately 86 tons of disaster relief supplies, including medicines, were dispatched in two IL-76 sorties and INS *TABAR* to affected place in May / June 2006.

(iv) **Nepal Earthquake in 2015 and 2018.** In the aftermath of these earthquakes, Nepal, a landlocked country was devastated and ravaged. Thousands of people were killed, many more injured and lakhs were left homeless. Indian Air Force and Indian Army relentlessly involved in the rescue and relief operations.

8.23 Similarly, during the crisis in Lebanon, 3,200 blankets and 225 tents were dispatched on 18 August 2006. Additionally, our Armed Forces have, on a number of occasions, assisted Pakistan, Sri Lanka, Bhutan, Bangladesh, Nepal and other neighboring countries, as in the aftermath of the tsunami (2004) and the Kashmir earthquake (2005). The Armed Forces always played a major role in building our national image in world forum. Disaster response / assistance to India's neighbors and other countries in the region can go a long way in establishing our status as a major regional power besides demonstrating the Indian culture of ***helping humanity sans frontiers***. Hence, the Armed Forces can expect a

[125] *"International Humanitarian Aid," Indian Army Official Web Site : www.indianarmy.nic.in*

significant role in disaster response in South Asia and even in far off countries in the times to come. The response to disasters in other countries has a number of additional operational, logistic and diplomatic dimensions and will have to be planned on the lines of ***out of area contingencies***. Operational capacities of the formations / units earmarked for such tasks will have to be built to be able to respond to emergencies, professionally and in keeping with the best global standards and Indian traditions.

8.24 **National Emergency Response Centre (NERC).** The High Power Committee, constituted by the MHA has proposed adopting the NERC for increasing the effectiveness of multi-agency response during major disasters. The NERC promulgates a system of functioning, where most competent and experienced person would be chosen to be the overall in charge. In NERC, the Armed Forces commanders may well have to function under this person, who could be from a different Government, department or quasi-Government agency and vice-versa. Hence, it is very important that the Armed Forces formations / units are aware of the requirements required to adjust or adapt to respond to a mechanism in accordance with the proposed system. Currently a National Emergency Response Centre is functional in Disaster Management Division of MHA and establishment of an Integrated Control Room for Emergency Response (ICR-ER) has been initiated by MHA. It will be connected to the following control rooms:-

(i) All agencies designated to provide hazard-specific early warnings
(ii) State Emergency Operations Centre (SEOC)
(iii) District Emergency Operations Centre (DEOC)
(iv) NDRF
(v) Integrated Defence Staff (CDS/ IDS)
(vi) MEA
(vii) CAPFs

The Way Ahead for Capacity Building & Development

8.25 **Contingency Planning.** Our existing plans predominantly address floods, cyclones and earthquakes. We need to identify all potential natural and manmade disasters and draw out well thought out, practically viable and flexible contingency plans for an appropriate and quick response at all levels and phases of the disaster.

8.26 **Synergy and Maximizing Capabilities.** Regardless of the revamping of overall structure, adequate interface between the main stakeholders, i.e., the Administration, Armed Forces, Public/Private Enterprises, NGO's and the Community is still found wanting. This might result in to lack of synergy and understanding of each other's capabilities and work culture. Crucial equipment like railway rakes, medical vans/ambulances, temporary mobile bridges, earthmoving plants, cranes and so on, should be identified by respective State/ Department, including BRO, GREF, State R&B Depts and certain major private civil construction companies preferably be placed at the disposal of Army columns till additional relief effort is mobilized. It is imperative that all agencies, including Army/IAF/IN, are mutually aware of the locations of each other's equipment. To that extent, the operationalization of India Disaster Resource Network (IDRN) (which was described in Para 128), is a step in the right direction.

8.27 **State of the Art Equipment.** Search & Rescue being the countries primary response function, there is a need to procure state of the art equipment to boost our capability to operate in all conditions. Detection sensors based on audio visual display would considerably increase our life saving capability. The equipment so acquired, should be common to all the responders.

8.28 **Dynamic Civil Military Liaison.** The initial stages of any disaster are very precarious. Therefore, the communication link between Armed Forces and Civil Authorities must function dynamically on a ***'two-way'*** and ***'pro-active'*** basis to facilitate coordinated response. Though fair amount of ground work has already been done by Armed Forces in this regard. it is necessary to evolve a formal frame work right up to district level for sustainability.

8.29 **Nuclear Disasters.** With the unprecedented level of proliferation of nuclear

technology our country is closure than ever, the nuclear disaster, whether intentional or unintentional is waiting to happen. A rogue radical outfit acquiring a nuclear device or dirty bomb is very much in the realm of possibility, an eventuality for which the nation is absolutely unprepared. Likewise, with increased emphasis on use of nuclear energy for power generation, the possibility of Chernobyl type of disaster cannot be overlooked.

8.30 Department of Atomic Energy is the designated nodal agency for this hazard without having any realistic capability on ground. The evolving disaster Management framework being largely coordinated by Min of Home Affairs, has so far failed to take any cognizance of this evolving threat. Though capabilities of the Armed Forces itself is very limited, but heartening to note that this is the only institution in India where training is imparted in the field of NBC to all the stakeholders. It is therefore necessary to further develop our facilities and nominate Armed Forces as primary responders in the unfortunate event of any nuclear disaster.

8.31 **Integrated Response by Armed Forces.** At the highest level, HQ IDS is jointly representing the Armed Forces (perhaps with the forming of CDS, some major changes could be envisaged). However, the jointness at lower HQ and at functional level is lacking. If Incidence Command System is promulgated in future, one sees no reason as to why Armed Forces cannot jointly coordinate the disaster response. Joint Coordination Cells are required at Command, Corps and Div / Area equivalent HQ of the IAF and Navy, and a Joint Task Force Cdr must be nominated for synergized application of the Armed Forces in Disaster Management.

8.32 **Challenges Faced by the Armed Forces in Disaster Management.** The Indian Armed Forces have played an important role in DM environment as a ***Force Multiplier***. However, they also face innumerable challenges while executing their tasks. Some of the

challenges are:-

(i) **Preparedness for Disaster Response.** As most of the disasters occur without any intimation especially manmade disasters and earthquakes, the reaction time to prepare for such contingencies is virtually none.

(ii) **Conduct of Relief Operations.** This is directly proportional to magnitude of the disaster. To tackle any mega disaster, at times their war preparedness gets jeopardized.

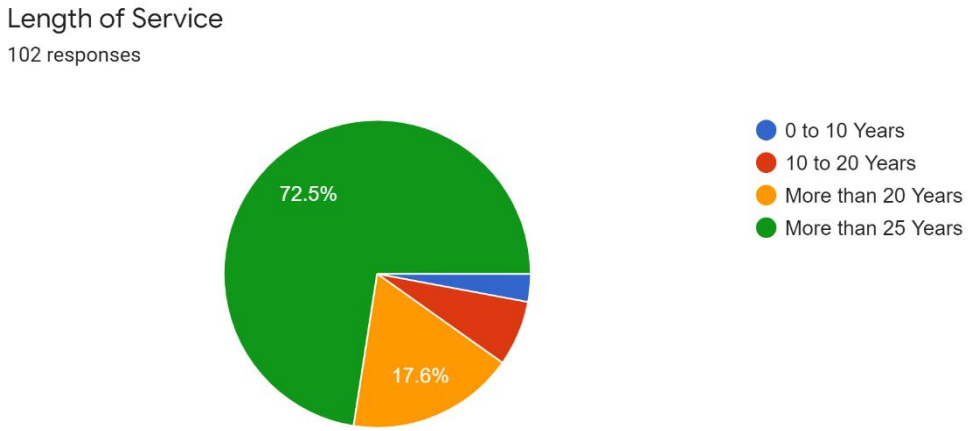
(iii) **Increasingly Uneven Frequency of Disasters.** In the recent years, both types; natural and manmade disasters have occurred and many a times; back to back incidents have taken place. Coping up such disasters combined with internal security roles has taken a tremendous toll on the Armed Forces.

(iv) **Being First Respondent.** In any major disaster, Armed Forces have always been the first respondent, thereby; they always had to face the unknown situation. The fear of unknown is always looming on them.

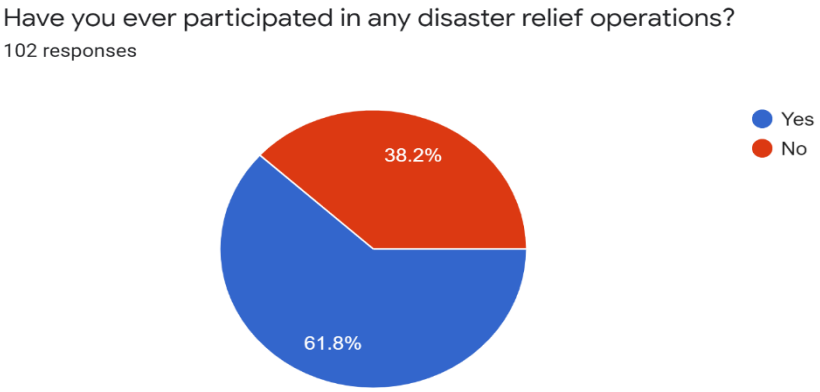
(v) **Resource Constraint.** This is their biggest challenge as they have to use their meager resources to tackle the disaster situation. The forces are already facing resource crunch and depleting budgetary allocation, hence mitigating any disaster with their own resources (which are mostly war waging equipment) is a daunting task for the Armed Forces.

ANALYSIS OF GOOGLE QUESTIONNAIRE

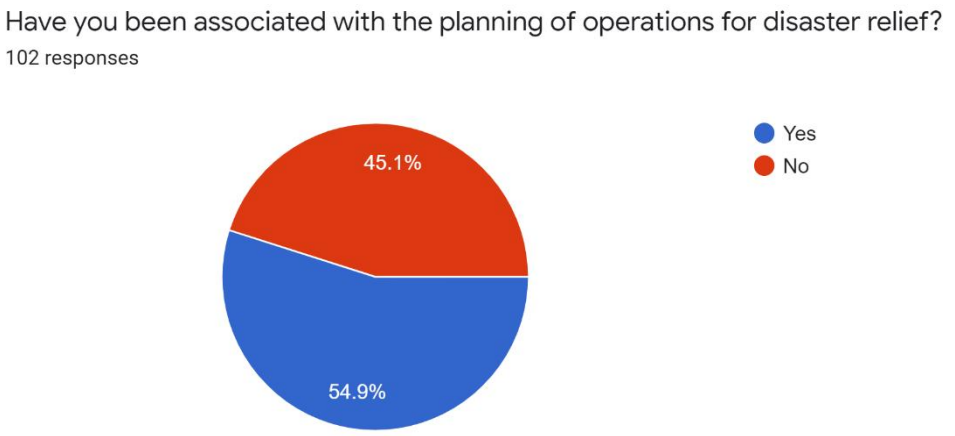
A Google Questionnaire as sent to more than 150 Serving / Retired Defence/ civilian personnel. ***The detailed questionnaire is attached as Annexure to the dissertation***. The aim of this questionnaire was to seek views of the personnel who have participated in actual operations or involved in planning stages of these operations. 102 personnel responded. Their detailed analysis is given below:



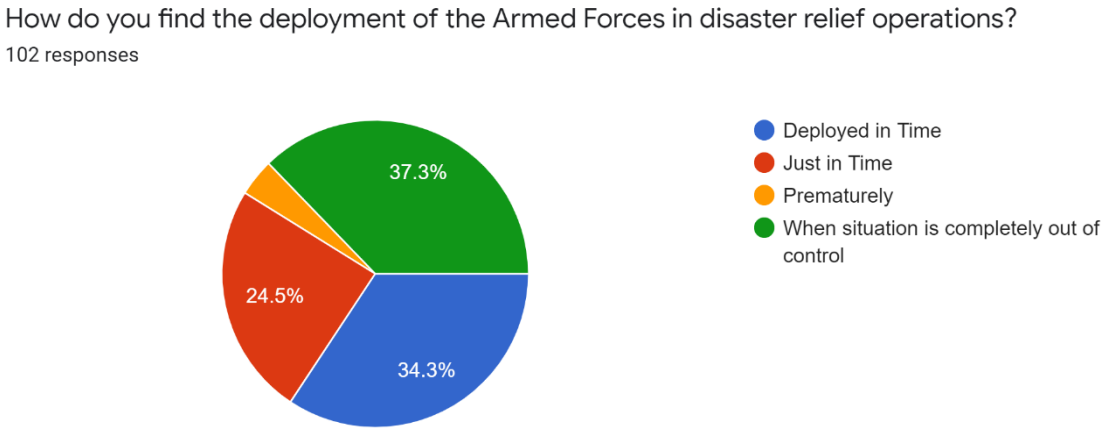
Of all the respondents, majority of them have more than 25 years of service and therefore has good assessment of role of the Armed Forces in Disaster Management.



More than 61% of respondents have participated in disaster relief operations. This helps to answer the subsequent questions keeping their personnel experience in mind and therefore the correct assessment.

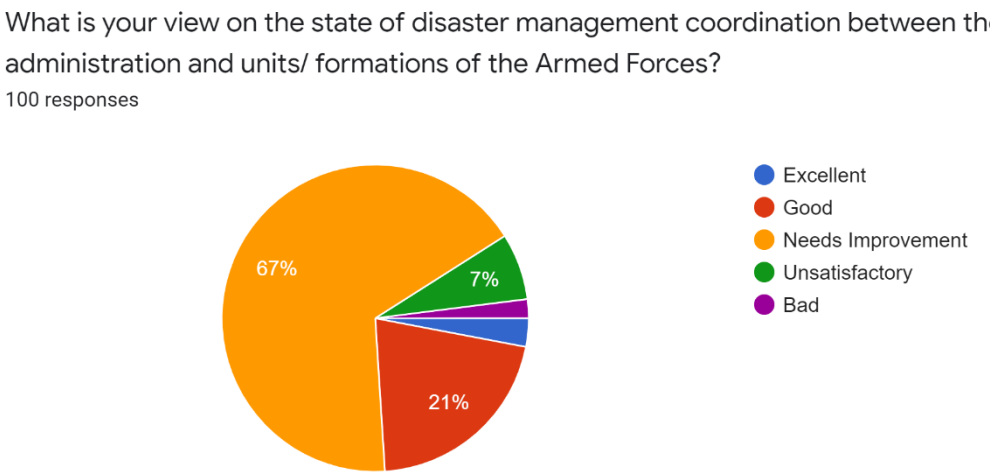


Around 55% of respondents have undertaken planning of disaster relief operations because of their experience. Hence their views on joint military operations and the challenges faced by Armed Forces should help in overcoming these issues in future operations.

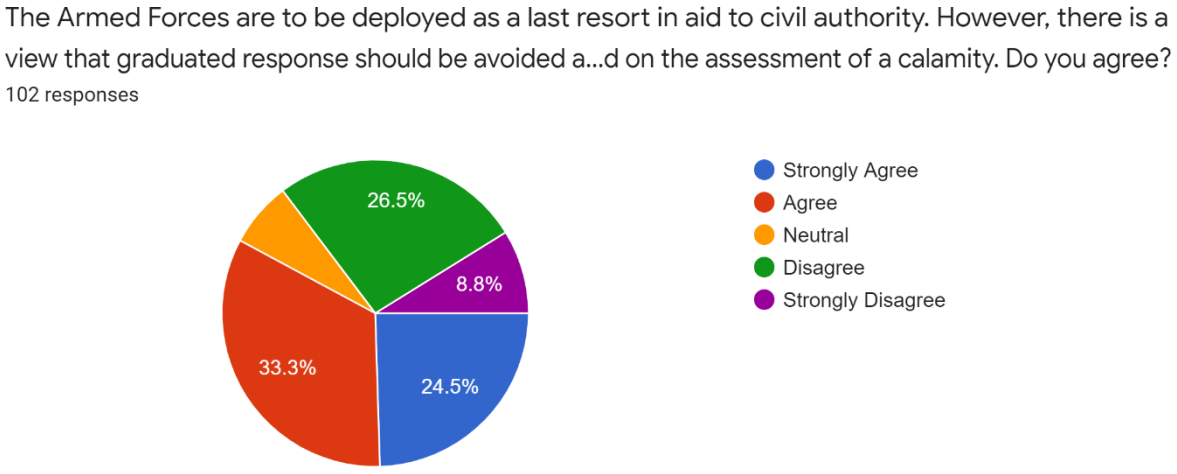


More than 37% of respondents feel that the Armed Forces are deployed when

the situation is completely out of control.

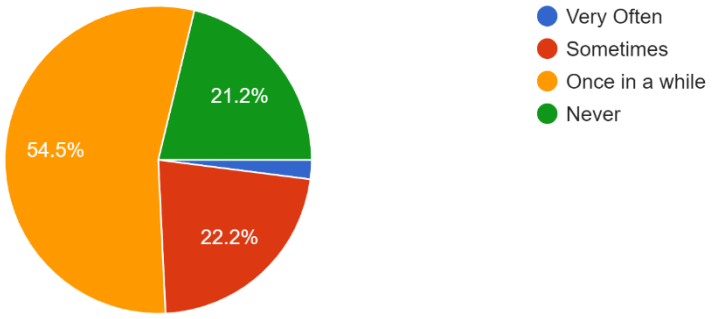


Coordination between civil administration and Armed Forces is one of the major concerns when it comes to conduct of relief operations and the same has been echoed by 67% of respondents who says it needs further improvement.



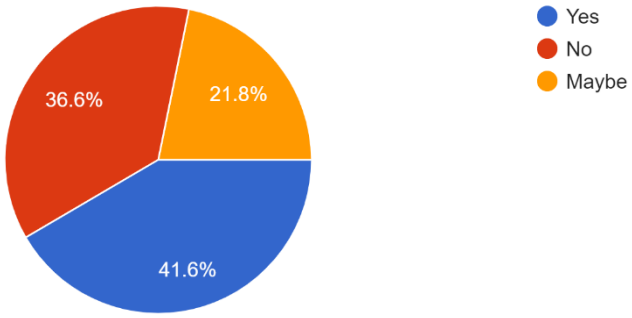
More than 33% of respondents agree that Armed Forces should be deployed in anticipation of a calamity.

How often are joint mock exercises by the civil administration and Armed Forces done?
99 responses



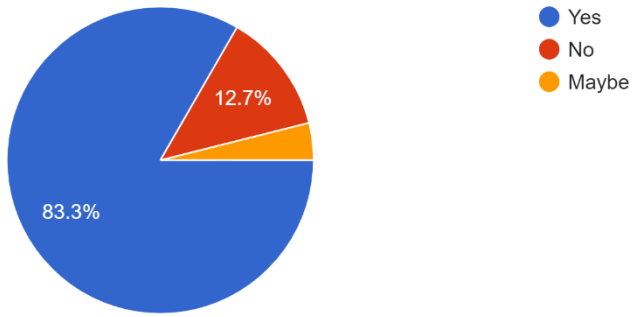
More than 54% of respondents are of the opinion that joint mock exercises are rarely carried out which results in coordination issues and more than often blame game regarding promptness and coverage of disaster relief.

Do the joint exercises increase the workload for its personnel?
101 responses



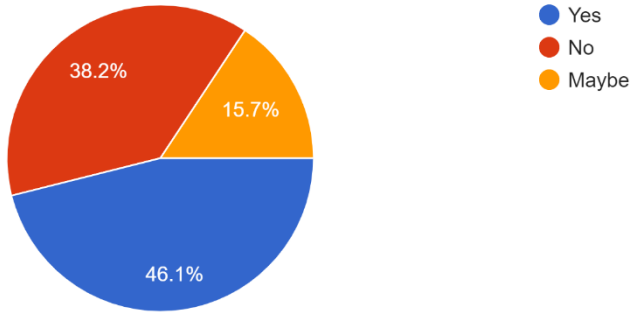
Almost 41% of respondents agree that the joint exercises increase the workload on its personnel.

Do you think that there is a growing trend of utilization of Armed Forces towards disaster response?
102 responses



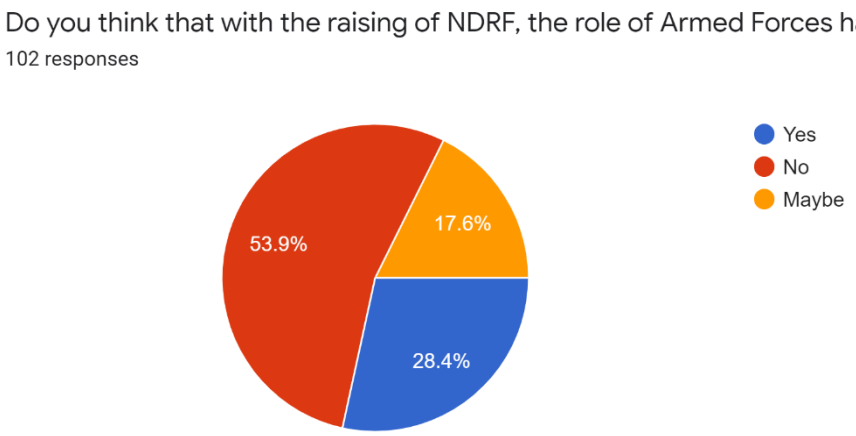
More than 83% of respondents feel that there is a growing a trend of utilization of Armed Forces which validates the point that the Armed Forces are more often than not acting as first responders.

Do you think the serviceability of equipment gets affected by its use during disaster relief operations?
102 responses

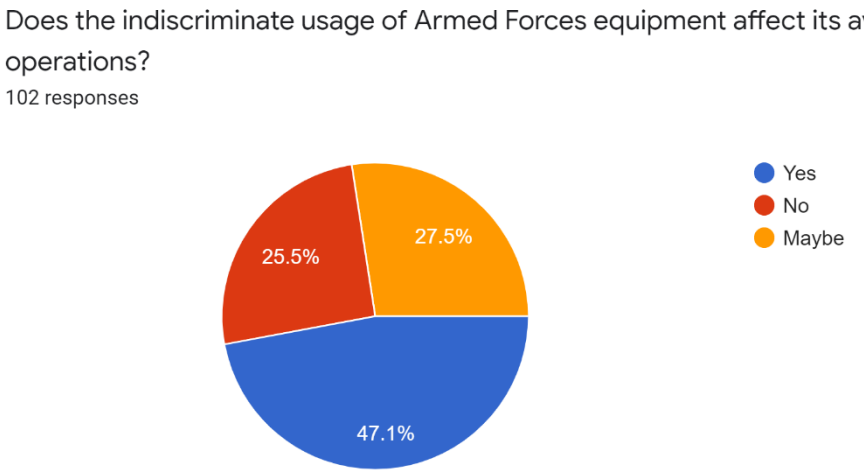


More than 46% of respondents agree that Armed Forces equipment serviceability gets affected when used in disaster operations. Another 15% personnel feel that maybe the equipment gets affected. This clearly shows that war fighting equipment of the Armed Forces does get affected in turn affecting the operational

preparedness for the duration till the equipment is replaced or made serviceable.

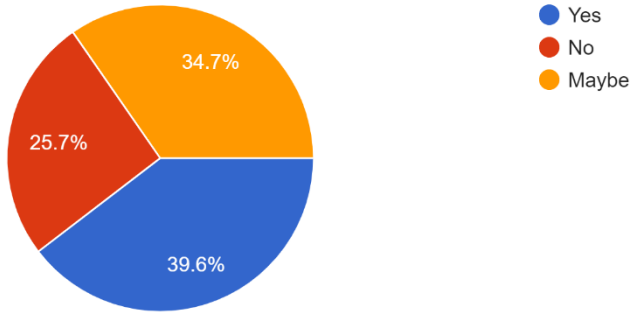


Despite the raising of NDRF, 74% of respondents feel that the role of armed Forces has not come down.



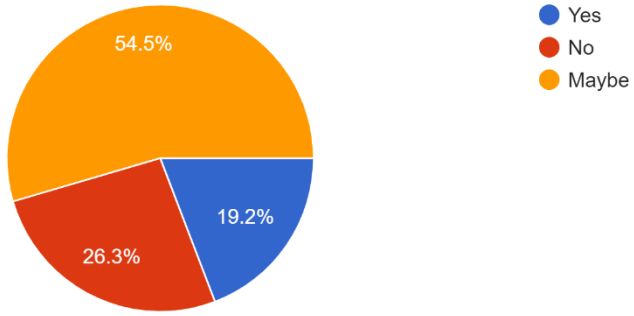
More than 47% of respondents feel that the usage of Armed Forces equipment affects its availability for actual operations.

In your opinion, does the occurrence of disaster and subsequent use of Armed Forces in these disasters affect the scheduled planned military exercises calendar?
101 responses



Almost 40% of respondents feel that routine training calendar gets affected because of participation of Armed Forces in relief operations. Certain exercises are planned keeping the suitability of climatic conditions, availability of equipment and personnel of other services in mind.

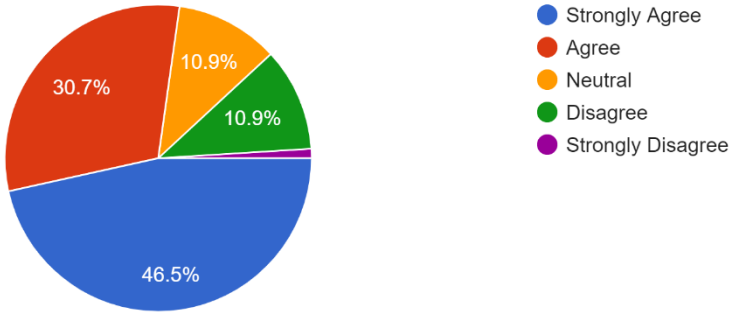
Do you think that there have been occasions of the utilization of operational equipment that have never been returned post the disaster response?
99 responses



Non-return of operational equipment is a major concern when Armed Forces are called upon to support civil administration. Between Yes and Maybe a total of 80% respondents feel this way. Non return of Navy's Gemini boats and rescue jackets in the Kerala flood relief is a glaring example.

Do you think that the Armed Forces must be given Disaster relief bricks to avoid the utilization of war fighting equipment?

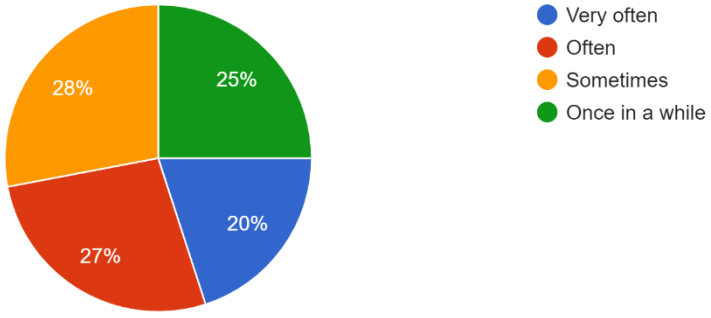
101 responses



Armed Forces have for a long time given the government this proposal of geographically dispersed disaster relief bricks. More than 46% respondents strongly agree that this will avoid utilization of war fighting equipment.

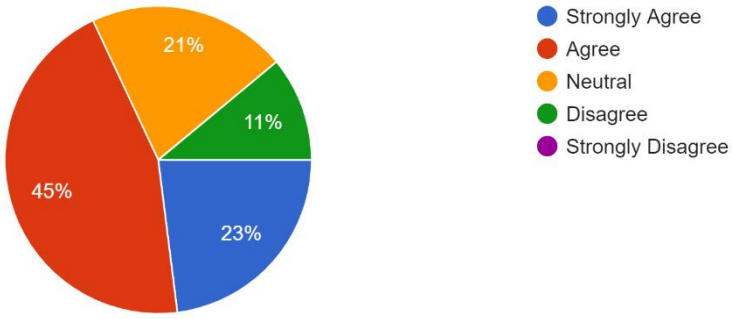
In your opinion, how many times it has happened that ration and fuel meant for Armed Forces is utilized towards disaster relief and the same is not reimbursed?

100 responses



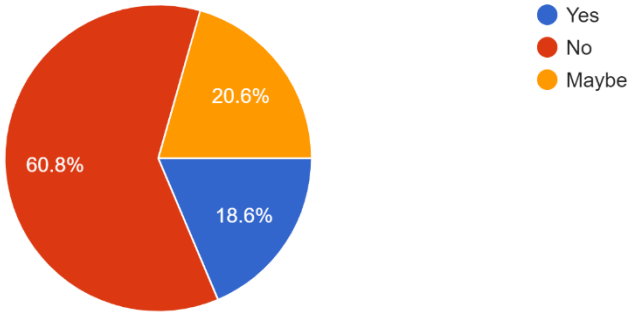
Almost 75% of respondents agree on some level that the ration and fuel meant for Armed Forces is utilized towards disaster relief and the same is not reimbursed.

Do you think that the Armed Forces are the first to reach and the last to return from the disaster?
100 responses

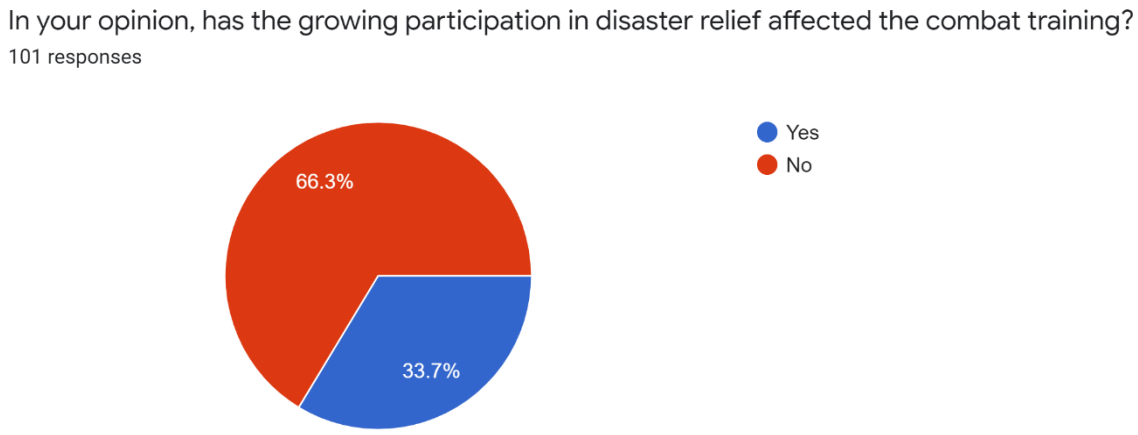


Almost 70% respondents feel that the Armed Forces are the first to reach and the last to return from the disaster.

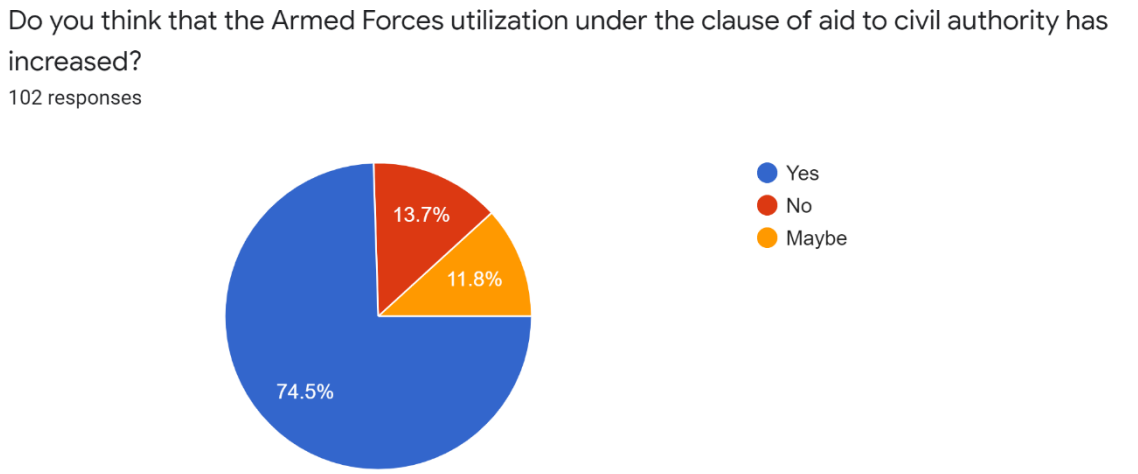
Do you think that the involvement of the Armed Forces in disaster response has affected the operational preparedness of the Armed Forces?
102 responses



Around 61% of respondents feel that the involvement of the Armed Forces in disaster response does not affect the operational preparedness of the Armed Forces.

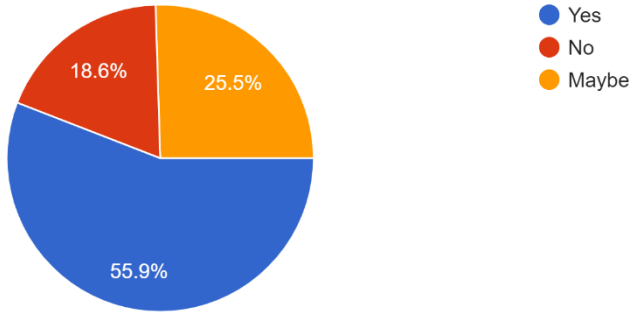


Two-third of the respondents are of the opinion that the growing participation in disaster relief does not affect the combat training.



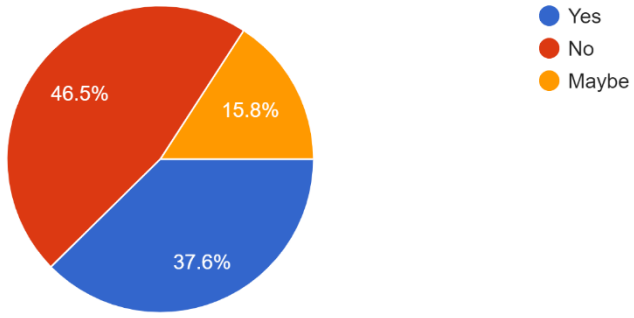
Almost 75% of respondents are of the opinion that Armed Forces are increasingly been used under clause aid to civil authority. This definitely undermines the capability of civil administration to deal with disasters and further erodes the faith of Indian citizens in civil authority.

Do you think that the Armed Forces utilization under the clause aid to civil authority comes much before the civil administration options and this leads to our resources getting exhausted?
102 responses



Further to the question above almost 56% of respondents feel that civil administration immediately seeks assistance of Armed Forces without first using their resources and expertise. This over dependence on Armed Forces is a dangerous trend because it not only adds pressure on Armed Forces but also does affect them in preparing for their primary duty which is to fight wars.

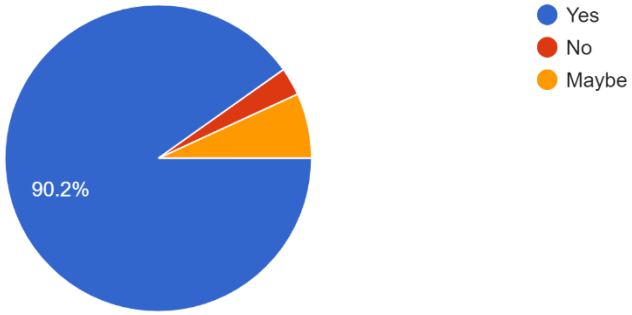
In your opinion, is India geared up to accept Artificial Intelligence as a tool for effective forecasting and mitigation of Disaster Management process?
101 responses



Majority of the respondents (almost 47%) are of the opinion that India is still not geared up to accept **AI** as a tool for effective forecasting and mitigation of Disaster Management process.

Do you think there is enough scope for the application of Artificial Intelligence in the field of Disaster Management in India?

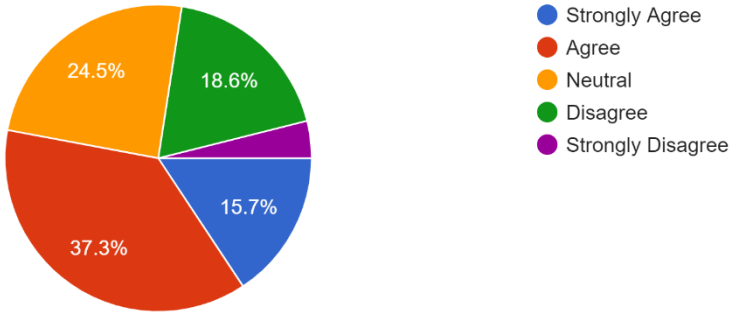
102 responses



More than 90% of respondents feel that there is more than enough scope for the application of **AI** in the field of disaster Management in India.

Do you feel that our country has enough data on Disaster Management aspects, so that the Big Data tools can be effectively used for the prediction and mitigation of disasters in India?

102 responses



Around 53% of respondents agree that our country has enough data on Disaster Management aspects so that the Big Data tools can be effectively used for the prediction and mitigation of disasters in India.

CHAPTER-IX

RECOMMENDATIONS

9.1 **General.** India is one of the most disaster-prone countries in the South Asian region with severe vulnerabilities to various man-made and natural disasters. Post Indian Ocean Tsunami in 2004, there was a ***"paradigm shift in India from a reactive disaster governance approach to a more proactive approach",*** which highlighted disaster ***Prevention, Mitigation*** and ***Preparedness***. However, there have been several uncertainties regarding the role, capacity and capability of the civil authorities, NDRF, CAPFs and the Armed Forces in Disaster Risk Management.

9.2 The facts discussed in previous chapters have conclusively proves the hypothesis that the Government's effort in evolving a comprehensive frame work of disaster Management suffers from rigid approach. There is a need to correctly appreciate the role of Armed Forces in Disaster Management. For their effective integration into evolving framework use the tools of decision sciences in optimizing the disaster Management process as a whole is very important.

9.3 Further, improvements and refinements are necessary in evolving the system which are result oriented and can focus on de-bureaucratization of the DM process by way of empowering the functionaries and stakeholders' by suitably evolving workable SoPs.

Role of Armed Forces

9.4 The catastrophic impact of disasters can be reduced only if there is coordination and cooperation from all sections of the society belonging to varied sectors. The Indian Armed Forces are one of the most dedicated and professional organisations with a rich tradition of being involved in the socio-developmental roles of nation building. Their

services should be utilised as a last resort and be called upon to intervene and take on specific tasks only when the situation is beyond the coping capability of civil administration as it involves high costs.

9.5 The contribution of the Indian Armed Forces in dealing with disaster needs no emphasis. This contribution is usually provided towards ***Aid to Civil Power.*** As laid down in the standing operating procedures, the Armed Forces are fully effective in ***Counter-Disaster Role***. Armed Forces when called for assistance, delivers a quick, positive and effective response to the situation due to their 24/7 nature of military training and operations. The dynamic organizational structure, capability of sustained operations in all adverse weather conditions, both by day and night, with validated management system of the Armed Forces make them particularly well-suited for effective disaster relief operations. In addition, many of their normal activities are parallel to those in public emergency services. Thus, Armed Forces can offer assistance to the affected, with invaluable support in engineering, communications, transport, search & rescue, emergency medical services, bridging, field sanitation, and water supply and so on. Armed Forces are structured and capable of a rapid response to disaster in any part of the country, or even overseas. They are well organized and capable to meet most of the needs, ranging from immediate life supporting assistance to short term rehabilitation requirement. Recommended tasks for Armed Forces in responding to disasters are as under:-

(i) Review, reconnaissance and damage evaluation of disaster sites.

(ii) Setting up of necessary command, control and communications structures.

(iii) Establishment of ***Composite Task Forces*** for search, rescue, evacuation and provision for immediate relief services, which would include medical aid,

trauma management, water & food supplies and establishment of relief camps or ECs.

(iv) Detection, disposal or deactivation of hazardous material/stores/ordinance.

(v) Assistance in maintenance of law and order.

(vi) Nuclear, biological and chemical disaster response in the extreme CBRN environment.

(vii) Deployment of Army religious teachers, medical counselors, trained education instructors for effective post counseling roles and trauma management of the victims.

9.6 **Can the Armed Forces be called only after Occurrence of a Disaster?** The Armed Forces are traditionally called to assist in the response stage of the disaster management cycle for search, rescue and relief operations. This is also the stage where timely intervention can minimize the losses if undertaken in a rapid and proficient manner. Time in any phase of the disaster is always at a premium. Hence, this is the most critical stage of the "Disaster Management Cycle" and timely and effective employment of the Armed Forces in search, rescue and relief operations can pay rich dividends in terms of preventive damage and saving precious lives. However, the moot point is at what stage is these forces are to be called? What if a major disaster is forecast and heavy losses appear imminent? Can it be assumed that the impending situation is within the means of the local administration or otherwise? There is no clear-cut answer to these questions. Ideally, the use of the military in most localized emergencies is not desirable. Civilian DM agencies/institutions should be able to respond and recover through the use of their own resources. However the desirability for usage of Armed Forces resources increases proportionally, as the scale of the disaster increases beyond the capability of

locally available personnel and resources. Therefore, deployment of Armed Forces resources is most appropriate during the ***response phase***. Nevertheless, an appropriate response requires preparedness and planning, thus it is absolutely essential that liaison, coordination, `needs assessment‟ and planning include military commanders in all disaster phases including mitigation and preparedness.

9.7 **Sharing of Information and Prior Warning of Imminent Danger.** The Armed Forces are always prepared and remain well-informed with the weather related news and weather forecasts. It would be sensible for the civil administration to keep the Armed Forces formations in the know of the developing crisis and / or even warn in advance to avoid any loss of time if any deployment is required. While mechanisms of this kind exist in a number of States, they need to function with the all seriousness. Hence, sometimes, the civil administration may have to requisition the aid from the Armed Forces in anticipation, even before the occurrence of a major disaster. However, such requests should be *resorted* to only in *critical emergencies*, that too when the civil administration has done its homework (for example; detailed analysis of emergency, available resources to respond and anticipated shortages and infirmities) and is confident its own response will not measure up to the magnitude of the emergency. The decision by the civil authority, regarding the Armed Forces' assistance is a crucial one, and must be made very judiciously, so as to ensure that the Forces *are called out for help only as a last resort*. Also, when employed, there should be absolute clarity regarding their role responsibility so that optimum potential/utility is ensured, with minimum loss of time[126].

[126] *Ref Solution Exchange for the Disaster Management Community by Col RK Verma published by Disaster Management Community dated 23 Sept 2009*

The Way Ahead for Capacity Building

9.8 The Disaster Management framework and plans are conspicuous by absence of clear cut strategy and role Armed Forces are expected to play. Within the limitations of the subject, it may be prudent to notice that preparing a force or establishment without role clarity may not be a sensible proposition, especially, if that force or establishment is neither trained nor raised for the role. It is, hence, necessary to first lay down, in an explicit manner, a well-defined role that the Armed Forces are expected to perform in disaster management. Role clarity would contribute significantly towards better preparedness and, hence, help in responding effectively and efficiently. As such, It needs to be understood that on account of peculiar organizational strengths and efficiency, Armed Forces would continue to be the primary respondent in future calamities, although it is highly likely that civ administration may be able to organize much more rapidly and relieve Armed Forces in earlier timeframes than experienced in the past.

9.9 One of the important peace time roles of the Armed Forces is to provide "***Aid to Civil Authority***" during disasters. This has to be viewed as a distinct emergency and needs to be tackled with full dedication with synergistic efforts from both the civil administration and the Armed Forces equally. While the slow onset of disasters like droughts and to some extent, floods, may be managed without the aid of the armed Forces, unexpected disasters like earthquakes / tsunamis and cloud burst or manmade disasters would require an emergency response where military resources would be needed to be deployed. Increased commitments of Armed Forces for internal commitments, may often lead to politicization and distract from their core function thereby compromise its combat preparedness. ***Alternately, intermediary security***

forces - i.e., Paramilitary and Central Police Organisations, Home guards and Civil Defence should be nurtured into making effective, elaborate and extended contributions in the rehabilitation and reconstruction phases of a disaster.

9.10 **Contingency Planning.** Our present plans primarily address only floods and earthquakes. We need to identify all possible nature/man-made disasters and draw out well through-out, practically feasible and flexible contingency plans for an appropriate and quick response at all levels.

9.11 **Relief and Aid.** This is an aspect, which assumes greater importance since very large quantities of relief material starts to arrive into the affected area. There is a need to exercise firm control as well as strict vigil in distribution and storage to affected persons, ensuring minimal wastage of relief. Suitable land or warehouse facilities must be identified for storing the relief aid pouring in from various parts of the world. Law and order has to be ensured by the district administration at all costs, especially near the relief camps and shelters. If required, help from the Armed Forces Police units may be requisitioned as they are apolitical in nature with clean image.

9.12 **Synergy and Maximizing Capabilities.** Armed Forces be fully integrated in evolving disaster Management framework by the revamping the existing structure and adequate interface between the main stakeholders, i.e., the Administration, Armed Forces, CAPFs, Public/Private Enterprises, NGO's and the Community. Critical equipment and resources like rail medical vans, bridges, earthmoving plants, cranes and so on, should be identified by respective State / Department, State R&B units and BRO preferably be placed at the disposal of the Armed Forces units till additional relief effort is mobilized. This would enable quick movement of rehab material and relief to scene of disaster.

9.13 **State of the Art Equipment.** Search & Rescue being our primary response function, we need to procure state of the art equipment to enhance our capability to operate in all conditions. The Armed Forces have so far been using the equipment which is meant for combat operations. The commitment of operational equipment for disaster relief can jeopardize their war waging capabilities can have serious consequences in the long run and can affect the operational preparedness adversely. The Services have aired this concern many a times publicly and have proposed that a separate inventory of equipment be maintained for use during rescue and relief operations. For easy operability, interchangeability, better spares & inventory management and multi-handling convenience by various agencies, the equipment so procured, should be common amongst all responders. The equipment will essentially be required, firstly, for the rescue workers for their own administration and, secondly, for search, rescue, relief, medical aid and rehabilitation of the victims of the disaster. In the case of incidents related to CBRN disasters, the inventory of equipment will be far too diverse, intricate and complex. While part of the equipment is common to the Armed Forces inventory, others, especially the R&D equipment, exclusively developed for the usage in the disasters may not be available with the military. Such equipment which is not in the inventory of the Armed Forces would have to be introduced separately. The team members and the units earmarked for the immediate response during disasters would have to be trained not only to use such equipment but also to maintain it and upkeep it in a serviceable condition. This proposal given to understand is under the consideration of the government.

9.14 **Dynamic Civil Military Liaison.** The communication link between Armed Forces and Civil Authorities must function dynamically on a ***'two way'*** and

'pro-active' basis, to facilitate coordinated response. It is recommended to evolve a formal frame work right up to district level. Therefore, for an effective coordination and successful implementation of the DM policies, it is recommended that the members of the Armed Forces should be part of DM related Executive Committees at all levels starting from the National and down to the Tehsil level.

9.15 **Nuclear Disasters.** Nuclear threat looming largely on India because of the statements and threats made by our neighborhood. The only institution which is geared up to tackle this situation to some degree is perhaps the Armed Forces. It is therefore necessary to further develop their capabilities and ***nominate Armed Forces as primary responders*** for all the nuclear and C B R N disasters.

9.16 **Integrated Response by Armed Forces.** Joint Coordination Cells are recommended to be established at Command, Corps and Div / Area and equivalent HQ of the Navy, IAF, ICG and thereafter, a Joint Task Force Commander must be nominated for synergized application and deployment of Armed Forces in Disaster Management at all the levels. ***Joint Services Doctrine*** for Disaster Management has already been prepared by the HQ Integrated Headquarters of the MoD. Efforts should be made by the Service HQ to identify and nominate core groups, domain specialists and field resources for rapid and immediate deployment of the forces at the scene of disaster. The other viable options that can be examined for undertaking the relief Ops by the Armed Forces, without compromising on the reaction and response time are:-

(i) Earmarking regular units based on composite task forces for specific disaster functions / response, state wise;

(ii) Raising Territorial Army (TA) units manned by veterans from all the three services and earmarking some of the units exclusively for DM role at a few disaster prone areas.

(iii) Utilisation of volunteer NCC cadets to work in the DM scenario directly under the aegis of the Armed Forces concerned, depending upon their specialization. For example, Cadets of NCC (Navy) can help in managing the Indian Navy's boats and dinghies and waterman-ship duties, NCC (AF) cadets can help out the IAF in air dispatch of relief material while NCC (Army/Tech) units can help the India Army in search & rescue ops and other rehabilitation process.

(iv) The Armed Forces should earmark a section of personnel and equipment at the battalion level for disaster management role and they should be trained accordingly.

(v) All the commands of the Forces must earmark and identify from where the men and material can be quickly mobilized and dispatched to the scene of occurrence without wasting time. They should be geared up with fully equipped centers to carry out relief and rescue activities in the region at short notice.

(vi) Territorial Army units and personnel to be integrated in disaster management plans. For extremely disaster prone States, creation of specialised Disaster Management Battalions similar to Ecological Battalions may be considered.

(vii) Border Road Organisation or GREF units; where available be suitably incorporated in disaster management plans.

(viii) There are huge numbers of capable Armed Forces veterans across the country. Efforts should be made to tap their potential for disaster management role. They should be employed for creating disaster task force at the State and Dist levels.

9.17 **Involvement of Home Guards, Civil Defence, NSS, NGOs etc.** Participation of various non-governmental stakeholders will be coordinated by the State agencies. Civil Defence, NYKS, Home guards, NSS and local NGOs will be encouraged to empower the community and create awareness through their respective institutional systems. With huge data base of these young and energetic voluntary forces, they would be a force multiplier in any disaster management scenario. Therefore, every effort should be made to motivate and encourage them to actively participate in DM process.

9.18 **Safe Construction Practices.** Vulnerabilities like earthquakes and cyclones do not kill people but poorly designed and badly constructed buildings do. It is recommended that safe construction practices, retrofitting of selected lifeline buildings, which are given in the national building code and earthquake resistant building designs, are to be adhered to and strictly enforced by the civil authorities. This is a critical step to be undertaken for effective earthquake mitigation. The design and specification of houses being constructed, under the Indira Awas Yojana (IAY) and other government welfare and development schemes, will also be re-examined and audited for hazard safety compliance. Updated Building codes will be circulated to the environment and put up in public domain. Adherence to the National Building Code should be made mandatory in all the State / Municipal building bye-laws. Training of engineers, architects, small builders, construction managers, masons and artisans has

already been started and needs to be intensified at the State and District level. Safe schools and hospitals (with large capacity) and National monuments besides other critical lifeline buildings will be regarded as a National priority and must comply with CFEES guidelines. Necessary provisions shall be made in all the Government Supported Schemes to design Hospitals, school buildings / hostels, public offices with earthquake resilient features with appropriate fire safety measures. Any of the structures not confirming to the laid down norms should not be permitted and defaulters should be dealt with severely.

9.19 **Standard Operating Procedures (SOPs).** All Central/State ministries and departments along with ***stakeholders*** must prepare SOPs and Checklist within their sphere of responsibility for quick reference and follow-up in the case of any eventuality. These SOPs must be prepared in consonance with State and district disaster plans. SOPs should be specific, disaster centric and must address the target population for ease of implementation. A copy of these must be circulated to all the stakeholders. Periodical review of the SOPs, checklists, disaster mitigating plans, evacuation process, location of ECs, transportation plans must be validated and thereafter reviewed periodically. Standardization of relief material must be ensured for easy operability and food packages, medicines etc must be checked for their validity, expiry and operability. Similarly, periodical inspection of All lifeline buildings in seismic zones III, IV & V like hospitals, railway stations, airports / airport control towers, fire station buildings, bus stands, major administrative, educational and religious centers will need to be evaluated and, if necessary, retro-fitted with appropriate material/structural strengthening techniques.

9.20 **Medical Response.** One of the most important phases of the Disaster mitigation process is the handling of Medical Emergencies. In all major disasters like earthquakes, Tsunamis and flashfloods, large numbers of people would perish, with many more getting injured and worse will be found missing. Post disaster there would many cases of trauma, shock, disbelief, psychic etc requiring psychological/psychiatric treatment and counseling. Medical response has to be quick and effective. The execution of medical response plans and deployment of medical resources has to be undertaken on war footing. Mobile medical hospitals and other resources available with the Centre as well as the Armed Forces units will have to be airlifted in a proactive manner. Accordingly, MHA, GoI must enter in to a strategic tie up with aviation units of the Armed Forces, CAPFs, ICG and private scheduled and non-scheduled operators for quick airlift of required medical stores and resources. Post-disaster management, vigil and monitoring of sanitation and hygiene services are critical to prevent any outbreak of life threatening pandemics.

9.21 **Science & Technology for Disaster Management.** While promoting the application of science for disaster management at the local level, we should search for scalable, affordable and sustainable solutions. In many parts of the country and in fact the world over, disaster risks are building up at an alarming rate. Our ambition must match the scale of the problem, reach out the scientific community and work towards futuristic agenda. Over the last few years, there has been a lot of enthusiasm for application of new technologies, therefore, Government at levels must invest adequately in science and technology in terms of research, innovations, creation of infrastructure and most importantly create congenial scientific environment for Disaster Risk Management (DRM). Support and encourage building and developing

innovative technologies in the field of Artificial Intelligence, Big data analytics, Robotics, Imagery Sciences, Geoinformatics, advanced digital technologies and Remote Sensing. Affordable technologies are the key to future mitigation of large scale disasters. The next generation of Scientific and Technological efforts therefore, need to be guided by the following four principles:-

(i) A sharper definition of DRM problems to stimulate scientific efforts that leads to progress. The practice of DRM has matured in the country and now it should be possible to pursue specific requirement from the scientific communities across the globe. Stakeholders must rely and dough tail their processes of DRM with scientific innovations.

(ii) Sustainability should be the buzzword while endorsing the application of science for DRM at various levels.

9.22 **Multi-disciplinary Approach.** The concept of multi-disciplinary approach to DRM is not new. Nevertheless, it is typically restricted to working across fields that study different hazards. For example, interactions of seismologists with landslide experts or flashflood experts interacting with meteorologists etc are very common. However, there is a necessity to expand the scope of multi-disciplinary approach to study the interaction between various hazards, current and future exposure of population, property and economic activity vis-à-vis the vulnerability. This of course is not an easy task and will require endeavors to push the stakeholders beyond their comfort zones. Finally, we must recognize that the new emerging technologies are not a substitute for the fundamental principles of good governance characterized by a responsive government and risk aware communities. The new methods and tools

should supplement and supplant the time tested practices of good disaster risk management.

9.23 **Training.** Training is the key to learning and enhancing the skills of an individual. While National Institute of Disaster Management, at New Delhi is doing an excellent job in imparting training at levels in the field of disaster management, it is recommended

that :-

(i) Local chapters of NIDM should be established at disaster prone States either by opening new ones or enter in to a collaboration with already established State disaster institutions or specialist institutions. For example, National Institute of Security Academy at Hyderabad may be entrusted with imparting training to the southern States similarly BSF academy at Tekanpur may be entrusted for the central States of India with specialist faculty drawn from the NIDM.

(ii) Earmarked uniformed personnel from the Armed Forces, CPMFs, SSBs, State police and fire personnel, State RTO personnel, and local road transport corporations' personnel and other local volunteer groups should be imparted disaster mitigation training by these institutions.

(iii) Free Online and distance education modules should be developed by this apex institution for the award of certificates to the participants.

(iv) Further with respect to the Armed Forces the following are suggested:-

(a) The military culture in itself provides for the enabling environment and right kind of attitude for performance during crises and disasters. It would, however, be prudent to further hone their skills in fields like search & rescue and rehabilitation process. With respect to routine skill

development, the Armed Forces can continue to train the earmarked units at unit and formation levels. However, it is suggested that the training curricula/programs should be formalized by incorporating disaster relief and response aspects in the training syllabi, of both for the Officers and other ranks at ab-initio stage as well as at various intermediate stages of career development of the service personnel.

(b) The specialist training, however, needs to be institutionalized. At present, each Service headquarters is resorting to training and utilizing its integral resources independently. With the formation of CDS in the MoD, various aspects that require tri-services integration both for operations and material would probably be addressed to enhance an effective joint response during crisis. Nonetheless, the Armed Forces did extremely well during the tsunami relief operations, Bhuj earthquake, and various other major disasters, yet, there are still many grey areas which require improvement and course correction through joint training and coordination. Joint training as well as joint contingencies rehearsals should also be planned with the new organisations that are being raised like the NDRF and also with others to include the paramilitary forces, civil Defence, home guards, fire and rescue services and police. This would not only help them in knowing each other well (both Strengths and weaknesses) but also facilitate coordination during crisis. In this regard. There could be two options to facilitate this:-

(aa) A joint training programmes could be organised for various sister Services for common skills like debris control, search and rescue

aspects, slithering, waterman ship training, handling of communication sets, etc. and the specialized training skills which are service specific e.g., deep-sea diving, scuba diving, handling of motor boats, air drops or para-drops, search & rescue thru Drones/UAVs etc can be organised independently by each Service. Other, civilian counterparts from CAPFs and DM administrators can be sensitized by the concerned or earmarked service HQ, so that during crisis, these civilian agencies would know where to fall back for assistance.

(ab) The second option is to have a Civilian Central Academy / Establishment having skill specific faculties for training like NIDM at New Delhi, where not only the Services people but personnel from NDRF, civil Defence, home guards, police, volunteers and even from corporate organisations can imparted with relevant training. This would not only facilitate the training to be standardized but this establishment may also be nominated as a single agency to provide certification for all trained personnel. It could function under the aegis of National Institute of Disaster Management / National Disaster Management Authority (NDMA). It would be worthwhile to study the system followed in the US, where the training is organised by the US Army Corps of Engineers and also by a civil set-up known as Rescue Training Associates.

9.24 It is recommended that a composite **'Disaster Risk Profiling'** of every region be undertaken to assist ***Decision Makers*** in planning preventive methods, achieve better preparedness and disaster response by:-

(i) Identification risk response measures.

(ii) Location of response task force.

(iii) Correct location of stores/bricks.

(iv) Establish suitable communication arrangements.

(v) Advance planning of disaster preparedness & mitigation.

9.25 **Research & Documentation.** Post disaster, many research institutions, scholars, educationists, financial institutions, philanthropic organizations, Non-Govt organizations, domain experts' carryout extensive field case studies, research, analysis, postmortem and evaluation of the occurrence of the event or disaster. The Government's concerned must archive all these reports, carryout their own SWOT analysis, evaluate the gray areas and identify gaps in the existing prevention and mitigation measures and also evaluate the status of preparedness and responses. Participating communities and agencies involved with DM can take maximize benefits from the opportunities/options identified by the mentioned institutions. The biggest challenge for any Government would be to accept the failures and identify the way ahead for further refining the DM processes and training needs. The lessons of past disasters should also be compiled and documented for future referrals and implementation of the suggestions /recommendations. The recovery and reconstruction process too must be analyzed threadbare. This knowledge and lessons learnt needs to be disseminated to all concerned stakeholders within the country and also shared with International organisations for improved regional cooperation in the field of DM.

9.26 **Big Data Collaborator.** Currently, the main players in the field of Big Data for resilience are mix of development agencies; governmental agencies, local and

international non-governmental organizations, public and private donors, private companies, philanthropic foundations and academic initiatives. Numerous United Nation's organisations have initiated experimenting with Big Data methods and tools to build disaster resilience. The UN Global Pulse consists of a network of innovation labs established in New York, Jakarta, and Kampala, where experts from the UN, governments, academia and the private sector collaborate on research and projects on Big Data for development and resilience. The UN Development Programme (UNDP) is also actively involved in Big Data for resilience[127]. The UNDP regional offices in Europe and Central Asia showcased the application of Data Science Techniques to identify socio-economic vulnerabilities and organized a '***data dive'*** in Vienna to improve poverty mapping. The UNDP office in China established a laboratory in partnership with a local internet services company to experiment with using Big Data to support development goals. Other promising Big Data work is being done by UNDP branches in Macedonia, Armenia, and Kosovo. Another UN agency, the Office for the Coordination of Humanitarian Affairs, in late 2014 set up a data lab in Kenya and released the Humanitarian Data Exchange, an open platform to promote humanitarian data sharing, automation, and interoperability. More than 40 organizations joined the platform, which was tested during the Ebola outbreak in West Africa and the earthquake in Nepal. India, with its huge knowledge bank and enormous potential in R&D in computer and data sciences; must be an active collaborator in all the world wide Big data developers.

9.27 **Application of Geoinformatics.** Extensive application of Geoinformatics' tools must be explored for effective DM process. Each State must undertake the digital

[127] *Data-Pop Alliance Report; Big Data for Climate Change and Disaster Resilience: realizing the Benefits for developing Countries Sept 2015.*

mapping of their vulnerable areas along with all possible locations of vital infrastructure, power and transmission lines; water sources and their pipe lines; availability and location of DM stores, medical sources etc. Micro-level hazard zoning work should be done and vulnerable areas must be clearly marked on the map. This will come handy during any disaster as it hastens up the recovery process. Disaster Manager must be sensitized if not trained on Geoinformatics tools, their application and source of availability in the environment.

9.28 **Sensitization of Disaster Managers, Planners and Decision Makers.** Sensitization of planners and decision makers can immensely help in minimizing the harmful effects of these events on communities. The first and foremost need is awareness generation among policy makers, administrators, engineers, architects, general public as well as the farming community.

9.29 **Ministry of Disaster Management**. Whether natural or manmade, the disasters are here to stay. Future disasters are going to be at massive scale due to phenomenal growth of economy as well as the population. Keeping in view of the tremendous inter-ministerial coordination, efforts and financial requirement it is recommended that a separate Ministry of Disaster Management (with independent charge under MHA) at the national level and a Department of Disaster Management at the state level be created. This will ensure enactments and formulation of necessary policy guidelines; provide legal framework for disaster management and all related matters including the financial aspects and implementation methodology.

CONCLUSION

9.30 There is no foolproof mechanism to combat any disaster. The policy of the Government to mitigate the disasters hitherto has been ***Reactionary*** whereas;

Pro-active policy is required to succeed. Strict adherence to laws to ascertain prohibited, restricted and warning areas are needed. The network of dissemination of information, sensitization of the vulnerable sections of the society and robust communication facilities should be strengthened in remote and risky areas. No processes can succeed without the participation of local people; therefore a participative model should be developed, for effective participation in the disaster response process. **Streamlining, Rationalization and standardization** are necessary to enhance the application of science & technology tools. Free tools and royalty free applications in the open source, will help immensely to lower costs, ensure interoperability and enhance scaling. Clear and transparent sharing protocols should be employed, including science and technological application and programming interfaces. For social media, standardized hash tags should be employed to reduce ambiguity among the public.

9.31 **Reach** of digital technologies must be factored into disaster management strategies. In respect to communications among stakeholders. In fact, Creation of a global repository with information on how digital technologies can be applied for disaster management must be a priority to the scientific community so as to raise awareness and understanding of the scope. Similarly, hundreds of applications of disruptive technology are underway around the world, but experiences are often buried in news articles and research reports. An information base would be useful for identifying digital interventions that have worked in the past. Understanding and application about different technologies may not be relevant to all the States as different State's circumstances, type of disasters and topography may differ from each other. Thus, collaborations with the private sector, Government agencies and academia

are prudent for understanding and applying disruptive technologies for disaster prediction, detection, response and relief.

9.32 **Training** is indispensable for the disaster community to understand how to react to a given disaster appropriately and responsibly. Training is a continuous process in the field of Disaster Management and will go a long way in hastening the entire disaster progression effectively. All the stakeholders including the Armed Forces must be exposed to the nuances of DM in all the phases for effectiveness.

9.33 **Legal Framework.** From the grim realities of having varied type of world's worst disasters, India has become a shining example for other countries to follow, in not only responding to her own catastrophic disasters (exemplified by 2004 tsunami), but also promptly respond to the needs of the neighboring countries too. There is paradigm shift in India from ***reactive approach*** to response and calamity relief (which is generally used to be after the disaster) to ***proactive approach*** of disaster prevention, preparedness, and mitigation[128]. With the passing of Disaster Management Act, 2005, establishment of National Disaster Management Authority with Prime Minister as its Chairperson, and disaster management training by the national Institute of Disaster management along with the Disaster Management Cell of the State Administrative Training Institutes will surely help India becoming disaster resilient. Beside these, the Govt of Indian has formulated much more legislation for implementation and mitigation of various disasters' processes which shows India's commitment to the Disaster Management.

9.34 **Role of the Armed Forces.** Armed Forces of any democratic nations will have a great deal to offer to their citizens during emergency and disaster situations. Although,

[128] *Disaster Risk Governance in India and Cross Cutting Issues edited by Indrajit Pal, Rajib Shaw Pp 58 pub by springer Nature Pte Ltd Singapore 2018*

it is clear that the military assets and resources must be selectively and judiciously deployed to supplement & augment, but not to replace the local and State civilian disaster management machinery. Furthermore, military commanders must have regular interaction, involvement in liaison, coordination and planning with civilian disaster agencies to ensure that if and when their assistance is required, the integration will be as seamless, quick and effective as possible. Indian Armed Forces are not synonymous with bureaucracy and command and control models; their effective integration into the disaster management matrix will depend upon finding an appropriate balance between community engagement and top down management approach. The fast, effective and decentralized response of the Indian military forces in numerous disaster situations in the past is the testimony to their ability to function in many crises, dynamic and disaster environments. To conclude, while there are many important roles for Armed Forces deployment in emergency and disaster management, an examination of relevant legislation and policy, cultural backgrounds, historical relationships between civilian and military organizations; civilian and military operating cultures and doctrine, make it clear that for democratically accountable governments and their sustainability, deployment of Armed Forces as 'supplemental resources' can be very beneficial for communities and citizens of the country. It is also doubtful whether the role of the Armed Forces will ever become redundant or the burden is ever going to decrease because of availability of other crucial mitigating resources to deal with major disasters. In support of the national endeavor to contain the loss of lives and property, the Armed Forces with its inherent culture, integrity, devotion and capabilities would continue to deliver goods in its crucial role in search, rescue and relief operations during all major disasters.

9.35 The most important aspect for an effective cooperation is to ensure ongoing planning, coordination, and liaison besides needs assessment between civilian and military officials. This is possible when mutual respect and understanding of sensitivity to their different cultures/work ethos/styles of leadership is maintained.

9.36 Finally, unless political commitment is translated into action, it would be very difficult to effectively manage the disasters. Disaster Risk Reduction is everybody's business; therefore, it must be ensured that disaster risk reduction as a national and local priority with a strong institutional basis for implementation. Capacity building and risk mitigation must be ensured for sustainable development – the cornerstones of the guiding principal for evolving a sound policy on Disaster Management philosophy.

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Glossary

- ***Natural Hazard:*** *A sudden or slow-onset natural event or process that may cause harm to humans or other organisms. Examples are floods, drought, earthquake, desertification, landslide, epidemic, and locust invasion.*
- ***Emergency:*** *An emergency is a deviation from planned or expected behavior or a course of events that endangers or adversely affects people, property, or the environment.*
- ***Natural Disaster:*** *As distinct from a hazard, a disaster consists of the combination of a natural hazard and its effect on the population and assets.*
- ***Disaster Management:*** *DM* ***Act 2005 defines*** *"Disaster as a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or be 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".*
- ***Vulnerability****: The characteristics and circumstances of a community or asset that make it susceptible to the damaging effects of a hazard.*
- ***Exposure****: The actual extent to which assets or populations are likely to experience a given set of hazards over time. Exposure plus vulnerability equals disaster risk.*
- ***Risk****: The combination of the probability of an event and its negative consequences. Risk is the potential or likelihood of an emergency to occur.*
- ***Impact:*** *The sum of the consequences if the risk does occur.*
- ***Resilience****: The ability of a system or community to resist, absorb, accommodate, and recover from the effects of a hazard, including preservation and restoration of essential structures and functions.*
- ***Planning****: Activities necessary to analyze and document the possibility of an emergency or disaster and the potential consequences or impacts on life, property, and the environment. This includes assessing the hazards, risks, mitigation, preparedness, response, and recovery needs.*
- ***Mitigation****: Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters and all those Activities that actually eliminate or reduce the probability of a disaster.*
- ***Preparedness:*** *Activities necessary to the extent that mitigation measures have not, or cannot, prevent disasters. In the preparedness phase, governments, organizations, and individuals develop plans to save lives and minimize disaster damage*
- ***Response:*** *Activities following an emergency or disaster. These activities are designed to provide emergency assistance for victims (for example, search and rescue, emergency shelter, medical care, and mass feeding). They also seek to stabilize the situation and reduce the probability of secondary damage.*
    - ***Armed Forces/Military:*** *Colloquially and interchangeably used to indicate personnel from the Indian Army, Air Force and Indian Navy.*