Rural Community Resilience and Disaster Risk Management

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About the Book

India, due to its geographical location is vulnerable to numerous natural hazards such as earthquakes, floods, cyclones, droughts, landslides, hailstorms etc. Risk of these hazards aggregates due to factors such as demographics, socio-economic conditions, unplanned urbanization, development within high-risk zones. Cumulatively, threaten India's economy, its population and sustainable development. In addition, India, by 2030, will become the most populated country. To add to the woes, global climate change projections indicate that both frequency and intensity of these natural disasters will increase and so is its vulnerability with consequent damages shooting up several folds (IPCC 2014). Such a situation warrants effective disaster management encompassing all stakeholders at every step of Disaster Management (DM) process, viz., preparedness, awareness, response, recovery and mitigation.

We cannot prevent or control the natural disasters, but with adequate preventive, precautionary and mitigation measures, we can significantly reduce the intensity of adverse impacts of the natural disasters. For instance, during the year 1999, a Super Cyclone created havoc in Odisha and resulted in the death of 9,843 people and severe destruction of infrastructure. But, in year 2013, a cyclone of similar intensity, named Phalin, resulted in no more than 47 lives lost. Such a drastic reduction in death rate was possible due to improved efforts of Disaster Risk Management by all stakeholders. Similar progress has been made in reducing the loss of life due to other natural disasters as well. This shows the importance of preparedness in disaster management. Preparedness is a product of awareness and this book is a knowledge module wherein various aspects of disasters and their management, such as Early Warning System, structural and non-structural interventions are presented.

The book, divided into five chapters, presents about type of natural disasters, their nature, impacts, effects and preventive measures to minimize their adverse impacts. The book also provides basic information about various multilateral frameworks and related domestic policy environment. It discusses about the institutions involved in disaster management and also about the community based disaster risk reduction.

I thank Dr Lenin Babu, Consultant, Institute for Social and Economic Change for this unique contribution and systematic approach to this book. I would like to thank MGNCRE Team Members for extending extreme support in completing this book.

Dr W G Prasanna Kumar
Chairman MGNCRE

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Chapter 1 Understanding Disasters

Introduction

India, due to its geographical location is vulnerable to numerous natural hazards such as earthquakes, floods, cyclones, droughts, landslides, hailstorms etc. Factors like demographic profile, socio-economic conditions, rapid urbanization, environmental degradation, climate change exaggerate India's vulnerability and hamper its sustainable development. Global climate change projections are indicating that both frequency and intensity of these natural disasters may increase and so is vulnerability and consequent damage may be shooting up several folds (IPCC 2014). Such a situation warrants effective disaster management encompassing all stakeholders at every step of Disaster Management (DM) process, viz., preparedness, awareness, response, recovery and mitigation and basic understanding about the concepts of disaster management. This chapter envisages introducing the student to basic concepts with reference to disaster management.

Objectives

This chapter envisages familiarizing the student to concepts like hazard, vulnerability, exposure, risk and different aspects of disaster management.

Chapter Structure

- 1.1 Hazard
- 1.2 Exposure
- 1.3 Vulnerability
- 1.4 capacity
- 1.5 Risk

It was during the month of October in 1999, that a Super Cyclone had its landfall in the state of Odisha.

During its course of landfall, it created havoc and resulted in the death of 9,843 people and severe destruction of infrastructure. After about fourteen years, i.e., in the month of October in the year 2013, the state of Odisha has witnessed another equally powerful cyclone, named as Cyclone Phalin. It also had landfall in the same area as that of Super Cyclone of 1999. But no more than 47 persons lost their lives due to the Phalin cyclone. This drastic reduction in death rate was possible due to improved efforts of Disaster Risk Management by the state government of Odisha along with involvement and participation of the community in mitigation measures (GFDRR, 2013a). This comparison underlines that the effectiveness of prevention and preparedness measures in minimizing the loss of life. But to evolve effective strategies, adequate understanding the risk posed by the disasters is essential. India has higher vulnerability due to its geographical location and hence needs effective management of disaster risk. A risk has three components that determine the extent and severity of impact, viz., Hazard, Exposure and vulnerability (Fig 1.1)

Risk = Hazard X Exposure X Vulnerability

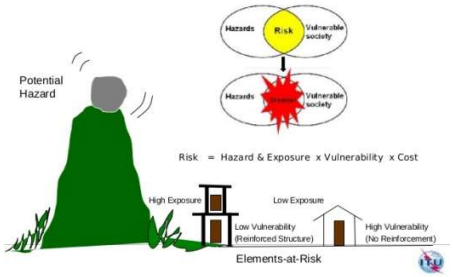

Fig 1.1: Defining Hazard, Vulnerability and Risk

1.1 Hazard

Hazard is defined "as a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards may be natural, anthropogenic or socio-natural in origin" (UNISDR, 2016). In simplest terms, the meaning of 'hazard' is a source of danger. It denotes a potential for the occurrence of an event which could be a substance, phenomenon or situation, that has the potential to cause damage or disruption to people and/or their property, their services and on their environment at some point of time. Thus, a hazard is a threat and a future source of danger. Some examples of hazards are earthquakes, cyclones, floods, hailstorms, landslides, and other such events. If these natural phenomena do happen in areas where there are no human interests, they do not constitute hazards nor do they result in disasters. But if it happen at places of human interests, then, we term these events as hazards as they have potential to cause harm to people (death, injury, disease and stress), human activity (economic, educational etc.,), property (property damage, economic loss) and environment (loss fauna and flora, pollution, loss of amenities) (Fig 1.2).

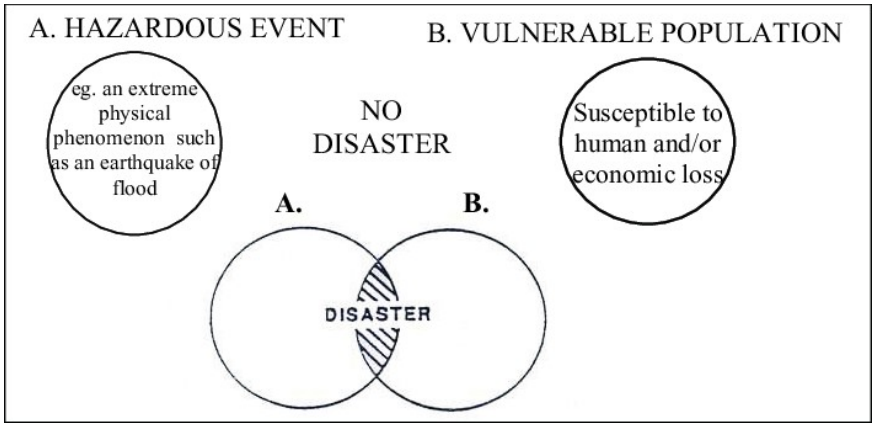

Fig 1.2: Relation between Hazard, Vulnerability and Disaster (Source: UN SPIDER 2009)

Hazards can be classified into different categories (Table 1.1).

I. Based on Nature: United Nations International Strategy for Disaster Reduction (UNISDR) (2017) has classified the hazards into different categories based on their nature;

- Geological or geophysical hazards withtheir origin in geological processes going on in the Earth, for instance, Earthquakes, Volcanic activity etc. These events are known to trigger secondary hazards such as landslides, tsunami etc.
- Hydro-meteorological hazards have their origin in atmospheric, hydrological or oceanographic components of earth. For instance, cyclones have their sources in the ocean while drought has its origin to the atmospheric component. These hazards have the capacity to exaggerate the intensity of other hazards.
- Biological hazards are of organic origin or conveyed by biological vectors, including disease causing microorganisms, toxins and bioactive substances, eg.,COVID 19, a virus, has brought the entire world economy to a standstill and has resulted in heavy loss of human life.
- Environmental hazards may be created by change in the nature/qualityecosystem components, viz., air, soil and water. Such processes and phenomena may be termed drivers of hazard and risk rather than hazards in themselves, such as global warming, soil quality degradation, deforestation, loss of habitat and biodiversity, sea-level rise etc.
- Technological hazards are unwanted products of the technological or industrial process going haywire due to infrastructure failures or specific human activities. Nuclear accidents, dam collapse, industrial accidents are examples of these hazards. These hazards may also be a result of impacts of a natural hazard event, for eg., anearthquake led to the generation of the tsunami in Japan and ultimately to an accident in a nuclear power station.

II. Based on Speed of Onset: Hazards differ in their speed of onset. Some disasters like earthquakes are very fast, not lasting more than a few minutes while some others are very slow in their onset like drought. Based on their speed of onset, disasters are also classified into rapid, or slow-onset hazards

- Rapid Onset: Very little time gap between the first indicator of hazard and its full intensity, for instance, earthquake, tsunami, flash floods etc.
- Slow Onset: Reasonable time lag between first manifestation and full intensity of hazard, for instance, drought, famine, desertification etc

The entire lifecycle of some disasters is less than a few hours to few days like landslides, floods, cyclones while others can linger for a very long time like drought, famine, epidemics like COVID 19 (Table 1). Every hazard has the potential to extract heavy cost in terms of life loss and economic loss. Theycan not be prevented fully. For instance, we can neither stop earthquakes nor can we change the trajectory of cyclones. But, appropriate measures could reduce their intensity or severity by adopting various strategies depending on the nature of hazard.

Table 1.1: Categorisation of Hazards

Sudden natural	Long-term natural	Sudden human-made	Long-term human-made
Avalanche Cold wave Earthquake Aftershock Floods Flash flood Dam collapse Volcanic eruption Glowing avalanche Heat wave High wind cyclone Storm Hail storm Sand storm Storm surges Thunderstorm Tropical storm Tornado Insect infestation Landslide Earth flow Power shortage Tsunami and tidal wave	Epidemics Drought Desertification Famine Food shortage or crop failure	Structural collapse Building collapse Mine collapse or cave-in Air disaster Land disaster Sea disaster Industrial/technological accident Explosions Chemical explosions Nuclear explosion or thermonuclear explosions Mine explosions Pollution Acid rain Chemical pollution Atmosphere pollution Chlorofluoro-carbons (CFCs) Oil pollution Fires Forest/grassland fire	National (civil strife, civil war) International (war-like encounters) Displaced population Refugees

Source: IFRCRCS 1993

1.1.1 Identification of Hazards is a very significant process as it would enable us to identify and help manage it properly. Hazard assessment is the first step for hazard mitigation planning. It prioritizes hazards so that a community or a government may use their discretion to plan and implement hazard mitigation action, involving an analysis of the chain or path of events leading to a disaster. For example, urban flash floods, which are caused by both natural and man-made factors. Man-made factors include choking of natural drains, major waterways by construction, urban spill etc. Thus, the hazard identification is a process that enables one to evaluate the potential of a situation to cause harm with an objective to find and record possible hazards that may be present in a given situation. This helps in minimizing the adverse impacts of a hazard. Hazard assessment studies depend on scientific understanding (like geologic, geomorphic, meteorological, hydrological data etc), historical information, (previous instances – written and or oral accounts from the local community). Various approaches can be adopted for hazard assessment, like, quantitative, qualitative, deterministic, probabilistic.

- **Quantitative approach**: Mathematical functions are used to denote relationships between variable considered to quantify the hazard. Numerical data can be fed in to assess the impact of the hazard event. For example, measuringa probable flood that a particular rainfall could cause within a watershed area. Flood dimensions such as depth of flood and area of inundation would depend on the volume of water that flows into the stream. Surface run-off, soil permeability, vegetation cover etc would determine this. The empirical data collected from historical records as well as theoretical data from basic principles of physics are used to derive the relationship between different variables. This method is widely used by the Irrigation Departments across the country. Rainfall in the catchment area is used to calculate the potential inflows into reservoirs and based on these calculation, water is released to downstream.
- **Qualitative approach**: This method uses ranking such as 'high', 'moderate' and 'low 'to assess a hazard event. Where there is a lack of sufficient data for quantitative evaluation, or where certain variables cannot be expressed numerically, this qualitative ranking may be appropriate to take hazard mitigation decisions.
- **Deterministic approach:** A past event is selected and associated characteristics and the consequences are described. Past impact data can be combined with current conditions and possible exposure levels and impact. This would be adequate to visualize the recurrence of an event for community awareness but leaves room for inaccuracies.
- **Probabilistic approach:** After identifying the hazards that affect the planning area and assessment of the impacts of those hazards, probability analysis is undertaken. It provides an estimate of the probability of each hazard affecting an area or region. Probability for each hazard may be categorized as 'high', 'moderate 'or 'low' Probability of occurrence can be calculated through research on past events.

1.1.2 Hazard Management

Presence of a hazard is bound to translate into a disaster sooner or later. Hence, it is in the best interest of all stakeholder to ensure that the hazard is removed altogether, if not, reduced to the extent possible. Following are some of the strategies to manage the hazards (Fig 1.3)

- **Elimination and Substitution** are the most effective strategies for reducing the hazard but is very difficult to achieve it from on-going processes. If the hazard identification was done at planning stages, then Elimination and Substitution can be very economical and also very effective. For instance, heavy rains during monsoons in Mumbai and hazard is in the form of flooding of rail tracks. As urban development in Mumbai city is already saturated, it is difficult to eliminate the hazard of flooding of rail tracks. On the other hand, identification of potential flooding during the planning stages of a new capital city like Amaravathi in Andhra Pradesh, eliminating the risk of flooding is easy as the city is still in the planning stage.

- **Engineering Controls** aim to protect the community by removing the exposure to hazardous conditions either by creating a barrier between the community and the hazard (like the construction of a dam to prevent flooding). Capital costs of engineering controls could be high but their lifetime, operating costs etc make them more economical. A simple example could be the construction of a Road-over- Railway line at an unmanned level crossing. It would simply remove the hazard of accidents on a railway track.

- **Administrative Controls** and Personal Protective Equipment (PPE) are more useful in the circumstances where the hazards are not well controlled, for instance, COVID 19 virus infection. Administrative Controls are aimed to alter the behaviour of community so as to minimize its

exposure to the hazard, for instance, to contain COVID 19 Virus, authorities across the world have ordered the places like markets, malls etc to close down, thus altering the behaviour of community to minimize its exposure to the virus. PPE aims to provide maximum protection to the individual member against exposure to hazard, for instance, wearing a respiratory mask against potential infection of COVID 19. These measures, Administrative controls and PPE are relatively easy to enforce and also inexpensive to establish but, in the long run, they may be difficult to sustain and also may prove to be expensive.

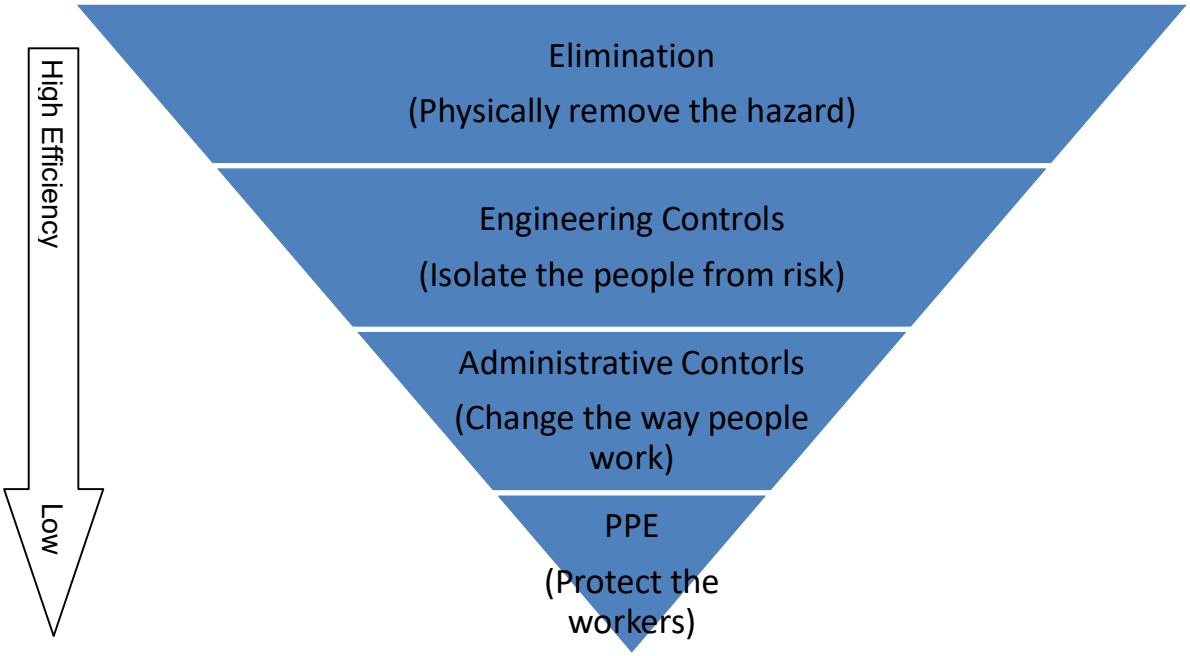

Fig. 1.3: Different Strategies of Hazard Management
(Adopted from: https://www.cdc.gov/niosh/topics/hierarchy/)

To Do Activity
List out the hazards, according to their intensity in your region
List all the hazards that have taken place in your district in previous year and measures taken to reduce the incidence and intensity of those hazards

1.2Introduction to Exposure

Various hazards do take place at one or other place on Earth. However, if a hazard or hazardous event takes place in an area where there is no human habitation, in other words, no exposure, then there is no risk (GFDRR, 2014a). But, many of hazard-prone areas, such as coastlines, volcanic slopes and flood plains, are places of extensive economic development and are places of high population density and thus increase the level of exposure (UNISDR, 2009b). For instance, an earthquake in an unpopulated, remote area may not cause any significant damage but the incidence of an earthquake of similar magnitude in a highly-populated area is bound to cause severe damages. It is the exposure that turns hazard into a disaster. United Nations International Strategy on Disaster (UNISDR 2009b), says that the Vulnerability as the extent to which people or economic assets are exposed and actually at risk. It is defined as “the situation of people, infrastructure, housing, production capacities and other tangible

human assets located in hazard-prone areas" (UNISDR 2016).

Exposure represents the people and/or assets at risk of potential losses or that may suffer damage to a hazard impact. It covers several dimensions like the physical (e.g. the built-up environment), the social (e.g. population distribution) and the economic dimensions. Exposure to hazard depends on several factors, for instance, one individual may be exposed to several hazards, for instance, during monsoon months, valley regions are exposed floods and also to the landslides. On the other hand, one hazard can result in the exposure of significant population and drought could be one of the examples as the entire farming community across several states (Fig 1.4).

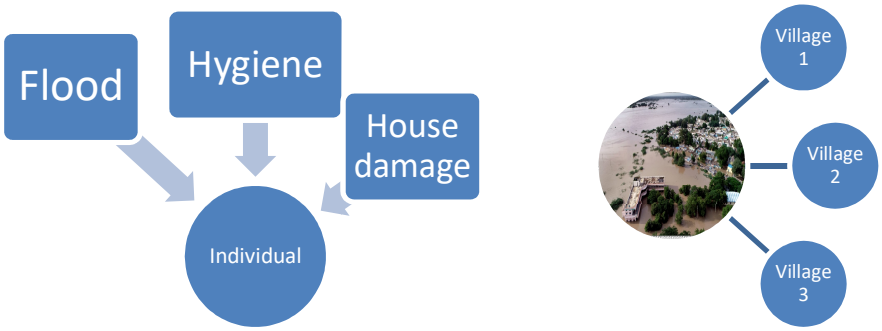

Fig 1.4: Single Vs Multiple Exposures
Source: UNISDR 2016

The extent of exposure is one of the drivers of disaster along with its intensity and frequency and the effectiveness of preventive measures or any other form of adaptation. For instance, it could be unplanned urbanization, demographic changes, modifications in building practice, and other socio-economic, institutional and environmental factors. Another area of concern, in terms of exposure, is Urbanization. It has been estimated that in 2018, about 55 per cent of the world's population lived in urban areas, an increase from 43 per cent in 1990. By 2050, more than two-thirds of the world's population is projected to live in urban areas. The number of cities with 300,000 inhabitants reached 1,860 in 2018, rising from 305 cities in 1950 and 976 in 1990 (United Nations, 2018). Such concentrated increase in urban centres with a high density of both human and economic assets indicates a very high level of exposure to natural disasters. Urban centres like Delhi, Mumbai, Kolkatta are the best examples of a very high level of exposure.

According to the Global Atlas of Human Exposure (Martino et al 2017), the global population and built-up surface exposed to natural hazards increased in the last 40 years. The world population potentially exposed to flood is around 1 billion in 155 countries in 2015. The highest increase, according to this report was in the category of Earthquake - the number of people exposed has increased by 93% in 40 years (from 1.4 billion in 1975 to 2.7 billion in 2015) (Table 1.2). Another, 414 million people lived near one of the 220 most dangerous volcanoes and could suffer from the consequences of eruptions. Flood, the most frequent natural disaster, potentially affects more people in Asia (76.9% of the global population exposed) and Africa (12.2%) than in other regions. 11 per cent of the area built-up on Earth is potentially exposed to this hazard, too. Cyclone winds pose a threat to 89 countries in the world and

exposed population increased from 1 billion in 1975 up to 1.6 billion in 2015, (about 24% of the world population) (Table 1.3 to 1.6).

Table 1.2: Population and Built-up Surface Potentially Exposed to Earthquake

	Year	Africa	Asia	Europe	Latin America and the Caribbean	Northern America	Oceania	N\A	total
Exposed Population (inhabitants)	1975	86,684,308	955,772,881	159,251,310	151,012,600	45,885,420	10,478,829	205,129	1,409,290,477
	1990	130,835,883	1,328,541,996	172,206,826	211,507,247	55,277,532	13,265,922	270,280	1,911,905,686
	2000	165,500,872	1,569,470,634	171,767,285	250,151,172	62,948,799	15,558,069	334,362	2,235,731,194
	2015	233,325,052	1,912,205,773	173,475,388	304,362,164	73,971,099	20,080,067	408,209	2,717,827,753
Exposed Built-up Surface area (Sq. Km)	1975	2,794	44,464	19,360	12,511	14,758	3,400	18	97,306
	1900	6,212	81,652	34,739	18,391	22,588	4,721	4	168,308
	2000	7,877	96,600	39,885	21,734	25,099	5,240	73	196,508
	2015	11,102	121,814	46,257	25,167	27,895	5,888	83	238,207

(Source: Martino et al 2017)

Table 1.3: Countries with the Highest Number of People Exposed to Tropical cyclone winds

Sl	Country	Population (in Millions)
1	China	665
2	India	165
3	Japan	126
4	Mexico	114
5	United States	111
6	Philippines	100
7	Bangladesh	87
8	Vietnam	58
9	South Korea	50
10	North Korea	25

(Source: Martino et al 2017)

Table 1.4: Population and Built-up Surface Exposed to Tropical Cyclone Storm Surge

		Africa	Asia	Europe	Latin America and the Caribbean	Northern America	Oceania	N\A	total
Exposed Population (inhabitants)	1975	879,180	68,247,894	92,330	2,550,298	10,415,126	395,336	186,243	82,766,407
	1990	1,120,275	93,203,252	101,334	3,368,884	11,445,015	495,678	4,999,277	114,733,716
	2000	1,548,971	113,359,870	96,018	4,409,197	12,564,833	588,383	5,322,027	137,889,300
	2015	2,231,988	138,764,515	93,490	5,540,910	14,092,042	756,330	353,438	161,832,715
Exposed Built-up Surface area (Sq. Km)	1975	28	6,116	8	377	5,193	177	19	11,918
	1990	61	9,463	11	545	7,237	296	539	18,153
	2000	103	11,112	12	659	8,086	352	641	20,964
	2015	121	13,859	15	752	9,185	419	33	24,382

(Source: Martino et al 2017)

Table 1.5: Countries with the Highest Vulnerability to Cyclone Surge in 2015

Sl	Country	Population (in Millions)
1	China	50.45
2	India	18.57
3	Japan	17.93
4	Philippines	17.63
5	United States of America	14.09
6	Bangladesh	13.40
7	Vietnam	6.15
8	Indonesia	4.99
9	Taiwan	4.45
10	Mexico	1.69

(Source: Martino et al 2017)

Current studies on vulnerability focus only on population and built-up areas but, several other aspects are also exposed such as agricultural land, infrastructure, pastureland, water resources, and ecosystem services. These aspects should also be included in future analysis to get an adequate understanding of the impacts of disasters.

On the other hand, exposure to natural disaster does not mean that they are automatically vulnerable to disasters. For instance, mangrove forests, though they are exposed to strong tides and subjected to flooding for a significant period, survive due to their adaptability. If proper adaptations are not in place, repeated exposure to disasters may result in higher vulnerability. For instance, forest fire. Some trees may survive a single incidence of a forest fire, but repeated fire accidents will wipe out the entire forest. On the other hand, populations could become resistant/ immune after repeated exposures as was the case with the Spanish Flu epidemic and probably with COVID 19 pandemic and result in reduced vulnerability.

To Do Activity

Can you find out the per cent of district population exposed to different hazards in your district

Find out the measures that have been implemented to reduce the exposure to hazards in your region.

1.3: Vulnerability

Vulnerability is defined as the propensity of exposed elements such as human beings, their livelihoods, and assets to suffer adverse effects when impacted by hazard events (UNDRO, 1980). Vulnerability is the human dimension of disasters and is the result of the range of economic, social, cultural, institutional, political and psychological factors that shape people's lives and the environment that they live in. The characteristics determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards (Twigg, 2004). For instance, during the winter season, as mercury levels go down, the entire population gets exposed to the cold temperatures. But, only those individuals - have-nots, who were unable to protect themselves against the bone biting cold, would lose their battle to survive. Similarly, according to the preliminary observations, the mortality rate in COVID 19 pandemic is higher in case of co-morbidity. Thus, the vulnerability differs from exposure and it depends on various factors and attributes of an individual (Fig 1.5).

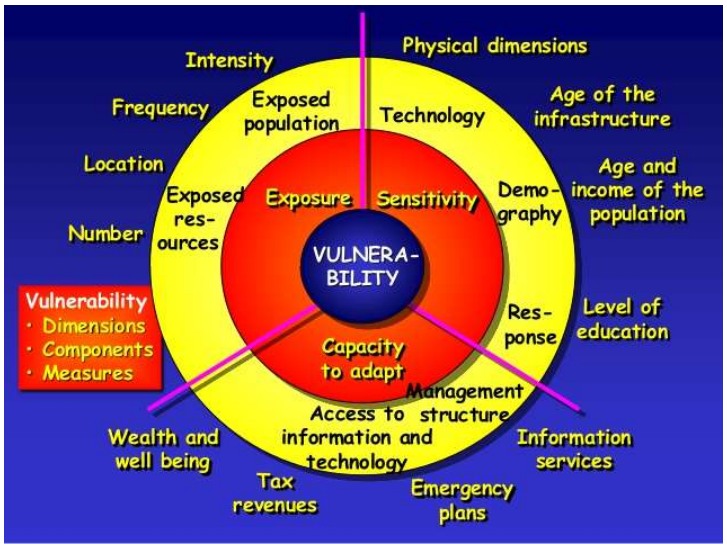

Fig 1.5: Determinants of Vulnerability

(Source: David Alexander, University College of London. https://www.slideshare.net/dealexander/vulnerability-to-disasters)

Poverty is both a driver and consequence of disaster risk (particularly in countries with weak risk governance) because economic pressures force people to live in unsafe locations and conditions (Wisner et al., 2004). The vulnerability relates to many factors, including:

- Physical factors, e.g. poor construction of buildings, unplanned land use, etc.
- Social factors. E.g. poverty, inequality, social exclusion and discrimination (gender, social status, disability and age) psychological factors, etc.

- Economic factors, e.g. uninsured informal sector, vulnerable rural livelihoods, dependence on single industries, globalisation of supply chains, etc.
- Environmental factors, e.g. poor environmental management, excessive consumption of natural resources, decline of ecosystem services, climate change, etc.

Further, factors like historical, political, cultural and institutional and natural resource processes also result in social and environmental conditions may influence and increase the vulnerability. For instance, living in dangerous locations like the construction of houses in flood-plain etc. (IPCC, 2012). Thus, the disaster risk not only depends on the severity of hazard or the number of people or assets exposed but that it is also a reflection of the susceptibility of people and economic assets to suffer loss and damage. Levels of vulnerability (and exposure) help to explain why some non-extreme hazards can lead to extreme impacts and disasters, while some extreme events do not (IPCC, 2012). Probably, the recent pandemic of COVID 19, looking at the survival and mortality rate, the infection appears not to be extreme hazard provided it is diagnosed in time and due medical care is provided. On the contrary, this pandemic has resulted in extreme hardship across the globe and is still blowing out of control in every nook and corner of the globe. In the context of COVID 19, some groups, such as people with other health symptoms like diabetes, respiratory problems are more susceptible to damage, loss and suffering than others and likewise, some people experience higher levels of vulnerability than others. Vulnerable groups are finding it hardest to reconstruct their livelihoods following this pandemic as most of the economic activities came to standstill condition and this, in turn, making them more vulnerable to the effects of subsequent hazard events.

1.3.1 Measuring Vulnerability

Vulnerability is complex. It has many dimensions, it is driven by factors at different levels, from local to global, and it is dynamic as it alters under the pressure of these driving forces (Twigg, 2004). Furthermore, the complex factors that make people vulnerable are not always immediately obvious. The causes of vulnerability can be both long and complex and therefore, no one single method can be adopted for assessing vulnerability. Ideally, any assessment should adopt a holistic approach to assessing vulnerability and methods are usually divided into physical (or built environment) and socio-economic vulnerability.

Assessing the vulnerability of the built environment to hazards is extremely important in assessing potential consequences of an event and for mainstreaming disaster risk reduction into the local development planning process. Understanding the response of existing structures to potential hazards, such as ground shaking from earthquakes and wind from tropical cyclones, requires the knowledge of building materials and engineering practices. This information base can only be reliably and sustainably developed at the local level (UNISDR, 2013).Efforts to quantify socio-economic vulnerability and poverty remain limited, and information of this kind is rarely integrated into risk assessments (GFDRR, 2014a). Quantifying social vulnerability remains a challenge, but indicators and indices to measure vulnerability have been created (quantified and descriptive), ranging from global indicators to those that are applied at the community level. These indicators are usually used to track changes in vulnerability over time. Vulnerability analysis involves understanding the root causes or drivers of vulnerability, but also people's capacities cope and recover from disasters in the form of Vulnerability and Capacity Assessments (VCA), primarily through participatory methods. A VCA considers a wide range of environmental, economic, social, cultural, institutional and political pressures that create vulnerability and is approached through different frameworks (Benson et al., 2007) (Fig 1.7). By identifying their vulnerabilities and capacities, local communities identify strategies for immediate and longer-term risk reduction, as well as identifying what they can do themselves to reduce risk.

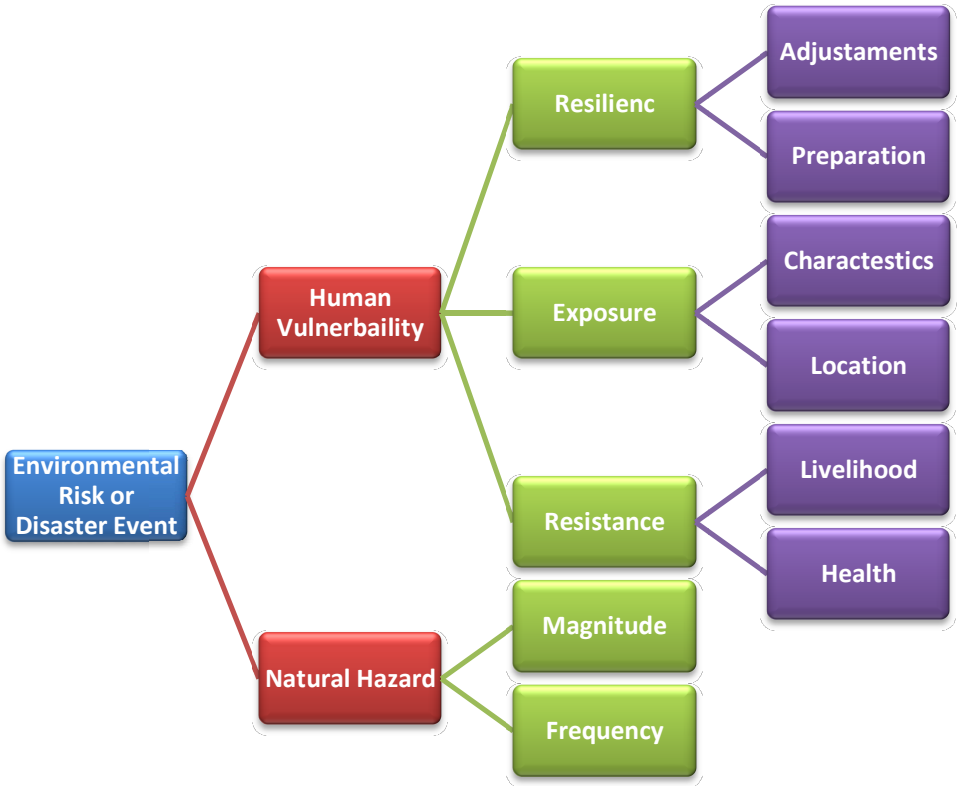

Fig 1.6: Long Chain of Vulnerability

(Source: Pelling, M. (2003) The Vulnerability of Cities. Natural disasters and Social Resilience.Earthscasn Publications, London)

1.3.2 Reducing Vulnerability

We cannot reduce the occurrence and severity of natural hazards, but reducing vulnerability is majorof the main opportunities for reducing disaster risk. The vulnerability can be reduced by appropriate measures, for instance, marine fishing. This sector is highly exposed to hazards, but by adopting strategies like avoiding fishing activities during cyclones, the exposure can be reduced significantly. There could some instances where avoiding the exposure to events may not be feasible, then, adoption of suitable measures may help to mitigate the hazard. For instance, some regions are prone to floods during the rainy season due to breach of the banks. By strengthening the banks and or dredging operations, the vulnerability of exposed areas can be reduced (Fig 1.3). The vulnerability itself changes over time because many of the processes that influence vulnerability are dynamic, including rapid urbanisation, environmental degradation, market conditions and demographic change etc. (DFID, 2004). Different approaches to vulnerability reduction include:

- Implementing building codes (Physical approach)
- Insurance and social protection (risk transfer)
- Emphasising economic diversity and resilient livelihoods
- Knowledge and awareness-raising (soft skills)
- Preparedness measures (capacity building)

The focus of disaster risk reduction(DRR)used to be on the risk reduction, such as the construction of multipurpose projects like dam construction etc,. However, of late, the focus of DRRis emphasis on i people's understanding and increasing their capacity to resist and recover from disasters, along with

overall resilience of people, society and systems (Fig 1.7) (SFDRR, 2015).

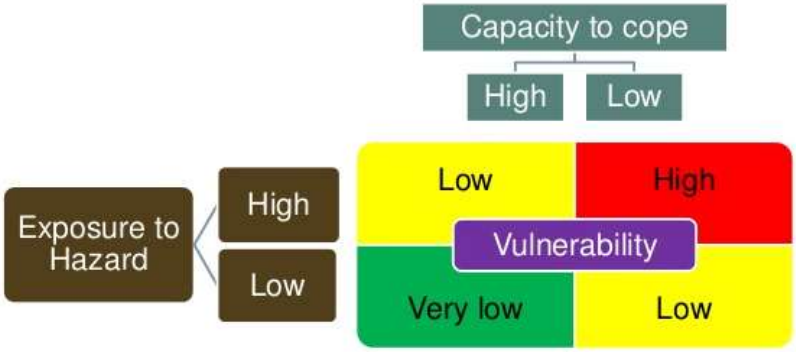

Fig 1.7: Impact of Capacity on Vulnerability

To Do Activity

- **Describe the vulnerability profile of your district**
- **List the measures implemented by district administration to reduce the vulnerability of population to hazards**

1.4 Capacity

The vulnerability of a community to any given hazard depends on the Capacity of that community to deal with given hazard. Thus, capacity is an important element in determining vulnerability. Generally, the capacity is referred to as the positive feature, i.e., higher the capacity, higher would be the capacity to reduce the risk of a hazard. Any measure that increases the capacity of a community is likely to reduce the impact of a hazard or disaster. Since the focus is on disasters, the term capacity, in general, has been associated with the immediate-term coping needs only. However, with climate change literature is also increasing, the term capacity is given another long-term perspective in the context of climate change, where the aim is to adapt to changes rather than to just overcome them. The existing scientific discourse distinguishes two different connotations, adaptive and coping capacity (Table 1.6).

- **Adaptive capacity** refers to the ability of a system or individual to adapt to climate change, but it can also be used in the context of disaster risk and it determines "the ability of an individual, family, community, or other social groups to adjust to changes in the environment guaranteeing survival and sustainability" (Lavell, 1999b).

- **Coping capacity** refers to the “ability of people, organizations, and systems, using available skills and resources, to face and manage adverse conditions, emergencies, or disasters” (UNISDR, 2009b). It indicates the extent to which a system can survive the impacts of an extreme event. It suggests that people can deal with some degree of destabilization, and acknowledges that at a certain point this capacity may be exceeded.

Table 1.6: Differences in Coping and Adaptive capacities

Dimension	Coping	Adapting
Exigency	Survival in the face of immediate, unusually significant stress, when resources, which may have been minimal to start with, are taxed (Wisner et al., 2004).	Reorientation in response to recent past or anticipated future change, often without specific reference to resource limitations.
Constraint	Survival is foremost and tactics are constrained by available knowledge, experience, and assets; reinvention is a secondary concern.	Adjustment is the focus and strategy is constrained less by current limits than by assumptions regarding future resource availability and trends.
Reactivity	Decisions are primarily tactical and made with the goal of protecting basic welfare and providing for basic human security after an event has occurred.	Decisions are strategic and focused on anticipating change and addressing this proactively, even if spurred by recent events seen as harbingers of further change.
Orientation	Focus is on past events that shape current conditions and limitations; by extension, the focus is also on previously successful tactics.	Focus on future conditions and strategies; past tactics are relevant to the extent they might facilitate adjustment, though some experts believe past and future orientation can overlap and blend

Source: IPCC, 2012

We can group capacity into two categories, viz., the capacity to anticipate and avoid, b) Capacity to change.

- **Capacity to Anticipate and Avoid**: Various Global Circulation Models have suggested that due to excessive Green House Gases (GHGs), global warming is taking place and that global climate change is certain. Butthe scientists are yet to say with conformity about the change at the micro-level. We need to minimise or reduce if not stop global warming and this condition warrants a type of capacity that is necessary in order to adapt to climate change. It involves conscious, planned efforts to reduce risk. This Capacity to anticipate the risk and work towards its prevention and reduction may constitute a series of elements, measures, and tools directed toward intervention in hazards and vulnerabilities with the objective of reducing existing or controlling future possible risks. This can range from guaranteeing survival to the ability to secure future livelihoods (Cardona et al., 2003a.;Eriksen and Silva, 2009).

- **Capacity to Respond:** Response capacity is mostly used to refer to the ability of institutions to react following a natural hazard, particularly in the post-disaster phase as an emergency response. Such capacity requires substantial ex-ante planning and investments in disaster preparedness and early warning. The most effective capacity to respond will often include combination strategies of risk reduction and enhanced capacities such as better preparedness, early warning and risk transfer measures like insurance.

- **Capacity to Recover and Change:** At times, natural disasters results in severe destruction and life loss. Under such circumstances, the capacity to recover depends on several factors, from the extent of a physical impact, the extent to which society has been affected, ability to resume

livelihood activities, mental and physical ability to recover, financial and environmental viability, and political will. At the same time, such circumstances, also, in a way, offer a great opportunity for change in the post-disaster phase. During the recovery phase, physical infrastructure being rebuilt, it offers flexibility to re-examine and restructure with suitable changes towards better resilience. But such considerations often tend to ignore the livelihood issues of a community but focus on safety issues only. Thus, most of the resettlement habitations remain unoccupied as effected people returned back to their original locations, simply because the new location does not allow them easy access to their livelihood systems. Returning to pre-disaster conditions might result in the same or even greater risk and illustrates that capacity to recover and change is severely limited by poverty.

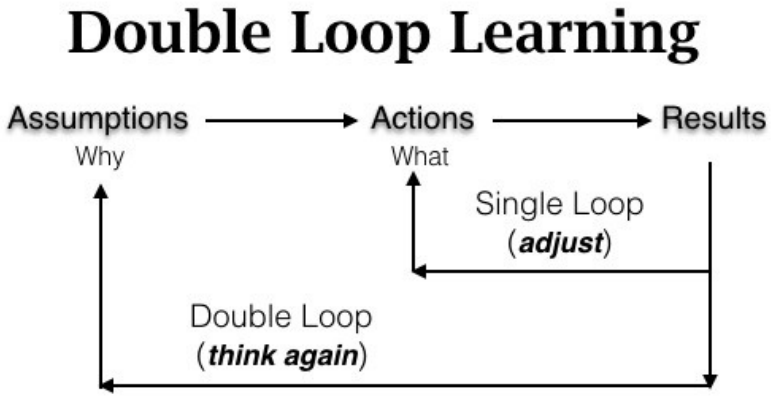

Fig. 1.8: Different Loops of Learning
(Source Folke et al.2009:15, based on Kolb's experiential learning cycle, Kolb 1984)

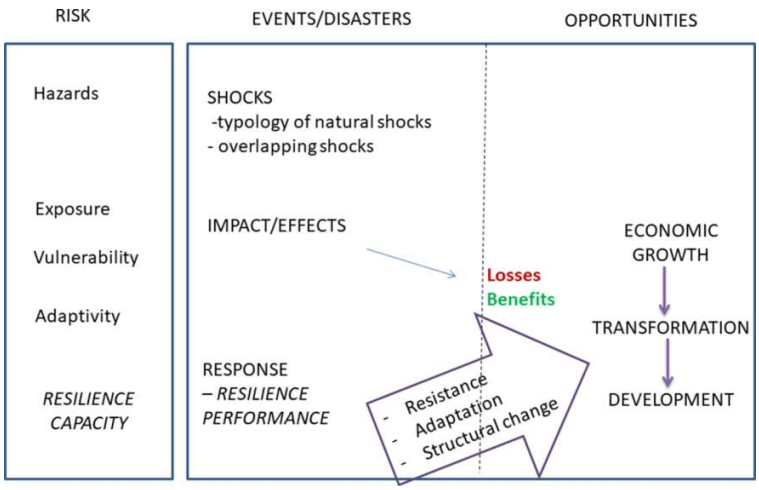

Fig 1.9: Influence of Repetitive Exposures
(source: Bănică,. & Nijkamp, 2020)

To Do Activity

- **Explain the role of capacity on vulnerability of a community to disasters**
- **Prepare a flowchart for capacity building programs for effected population in your district**
- **What Departments at district level are primary stakeholders due to disasters in your district**

1.5 Risk

The "risk" in general is defined as the expectation value of losses (deaths, injuries, property, etc.) that would be caused by a hazard and disaster risk can be seen as a function of the hazard, exposure and vulnerability as;

Disaster Risk = function (Hazard, Exposure, Vulnerability, capacity)

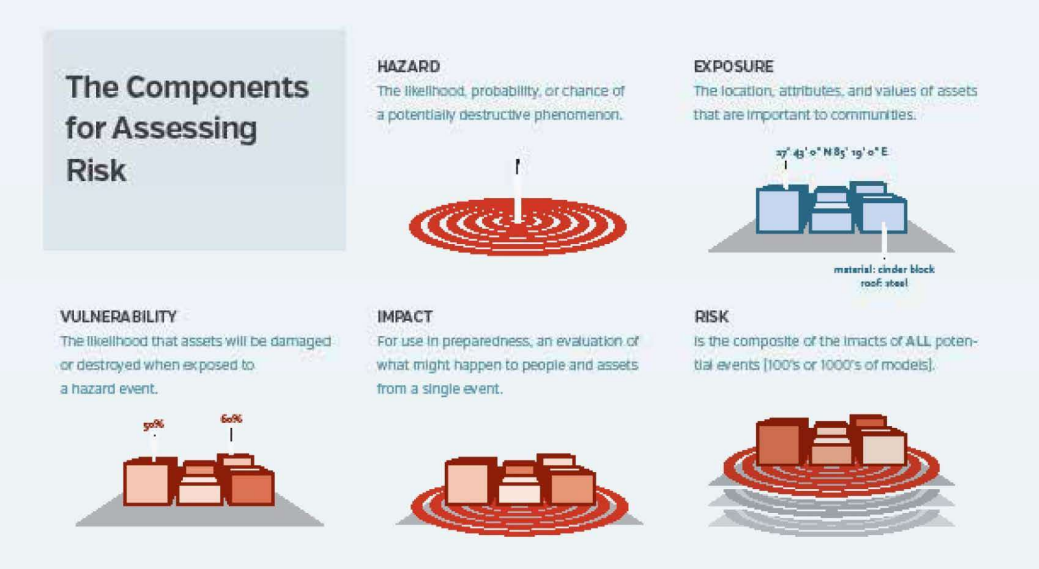

Fig 1.10: Components of Risk (Source: World Bank 2014)

As described in earlier sections, the risk is an accumulation of hazard, exposure, vulnerability and capacity. To reduce the risk, it is imperative to reduce the extent and intensity of hazard, reduce the exposure to hazard and vulnerability of exposed community by means of increasing their capacity, both adaptive and coping capacity. To achieve all these aspects, there is a need for systematic management of risk and the current risk management theory and policy was evolved over the years (Box 1.1). UNISDR has described the gradual but paradigm shift in the understanding of the risk as follows;

> "…Traditional understanding of risk can be likened to a view of the Himalayan peaks from above, with a cloud cover that obscures the topography below. From above, humans have described and named these peaks of risk as if they are separate and independent, when in fact, below the clouds, the connections are clear. Significant and influential peaks of risk occur that do not rise to the level of the clouds and currently remain obscured from view but are nonetheless highly relevant' (NDRR 2019). (Fig 1.10)

1.5.1 Systematic Risks: We generally classify risks into earthquake, floods, cyclones, landslides etc. However, systematic risks, by definition, are emergent and not necessarily obvious until the disaster occurs. But, they are typically obvious in retrospect – a result of a series of events that cross human-imposed boundaries, whether institutional geographic disciplinary, conceptual or administrative. We may not be able to place these disasters resulting from systemic risks into traditional disaster taxonomy.

Box 1.1: Risk Management over the Years

The 1970s Having observed that actual and potential consequences of natural hazards were becoming so severe, and were of such a scale, that much greater emphasis on pre-disaster planning and prevention was imperative, the United Nations Disaster Relief Coordinator convened an International Expert Group Meeting in July 1979 to review six years' worth of work developing a methodology for risk and vulnerability analysis.

1980s This work laid the foundations for the development, 10 years later, of the International Framework of Action for the International Decade for Natural Disaster Reduction (IDNDR), beginning on 1 January 1990.

1990s Supported by a Secretariat established at the United Nations Office in Geneva, IDNDR was intended to reduce – through concerted international action – loss of life, damage to property, and social and economic disruption caused by "natural disasters", especially in developing countries. With a strong emphasis on engaging and deploying existing scientific and technical knowledge, IDNDR succeeded in raising public awareness – notably of governments – to move away from fatalism and to reduce disaster losses and impacts. A pivotal moment in IDNDR was the adoption (in 1994) of the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation, containing the Principles, the Strategy and the Plan of Action (Yokohama Strategy) at the World Conference on Natural Disaster Reduction.

1994 The Yokohama Strategy marked the beginning of a significant shift in the political and analytical context within which disaster reduction was being considered. While IDNDR was largely influenced by scientific and technical approaches, the Yokohama Strategy attributed great importance to socioeconomic vulnerability in disaster risk analysis, emphasizing the crucial role of human actions in reducing the vulnerability of societies to natural hazards and disasters.

2000s The Yokohama Review found evidence of greater official and public understanding of the effects of disasters on the economic, social and political fabric of societies, and stated that "significantly greater commitment in practice is required".

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

2015- 2030: Adoption of Sendai Framework for Disaster Risk Reduction.

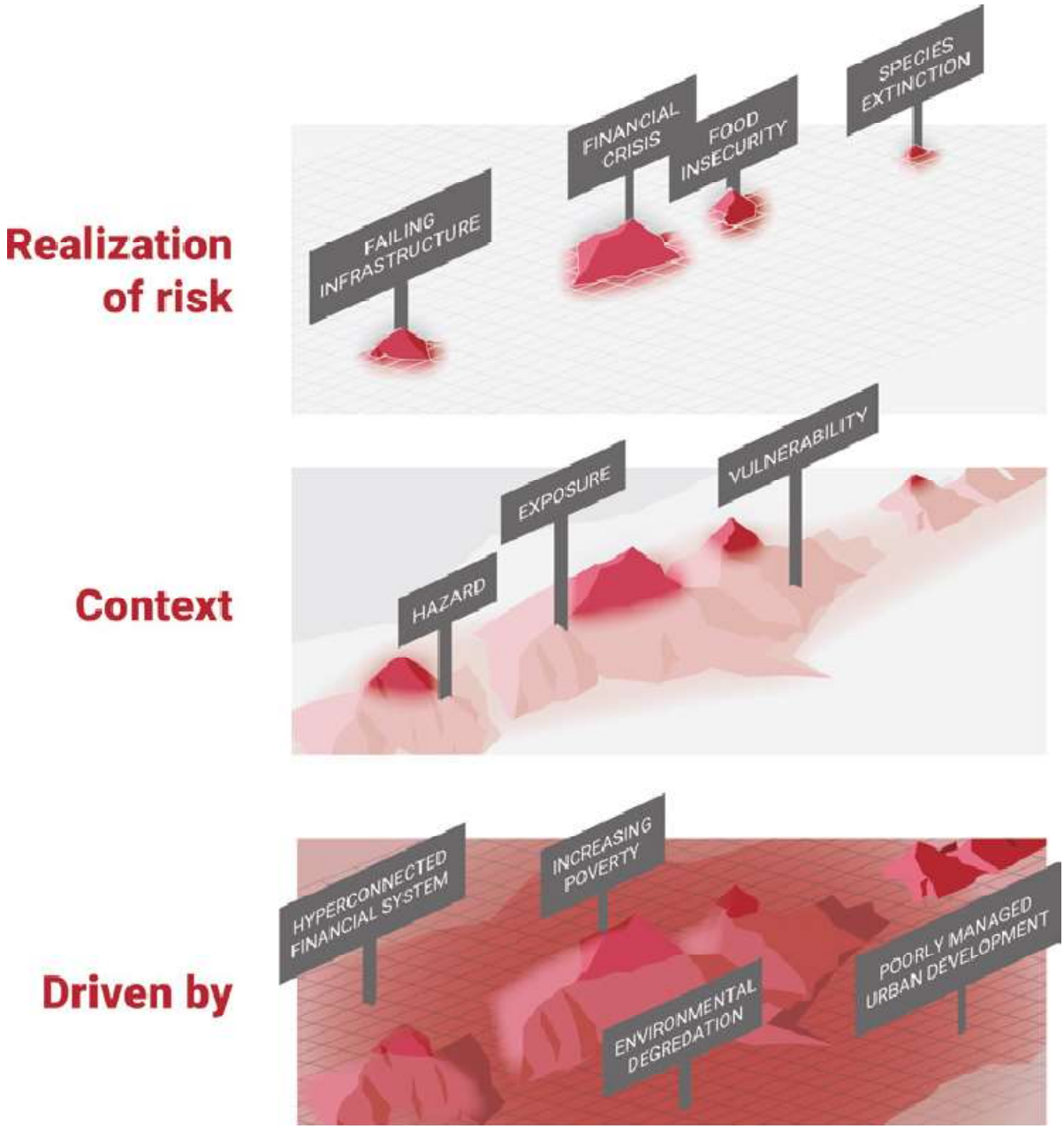

Fig 1.11: Topology of Risk (Source: UNDRR 2019)

1.5.2 Risk Assessment. Before proceeding to risk assessment, it is important to differentiate between complicated and complex systems. In simple terms, complicated systems are those systems where the sum of all sub-systems is equal to the main system. For instance, aero plane consists of thousands of sub-systems and multi-hazard systems can help to keep the risks at a manageable level only. On the contrast, a complex system exhibits emergent properties that arise from interactions among its constituent parts, for example, social unrest on account of a natural disaster like multiple breadbasket failures.

Box 1.2: Definitions of Systematic Risks

Systemic risk – a risk that is endogenous to, or embedded in, a system that is not itself considered to be a risk and is therefore not generally tracked or managed, but which is understood through systems analysis to have a latent or cumulative risk potential to negatively impact overall system performance when some characteristics of the system change.

Femto risk – a seemingly small-scale event that can trigger consequences at a much higher level of organization, often through complex chains of events (after Simon Levin 2011).

Systems risk – the inherent risk of a system when substantive elements of the system contribute to the entire system having a certain risk profile, which could be anywhere on the risk spectrum from very low risk, as an intact rainforest ecosystem, to very high risk, like a tar sands mining system.

Network hyper-risk (after Dirk Helbing 2013) or cascading multiple systems risk – the inherent risk across multiple systems when there are substantive elements contributing to the system of systems having a certain risk profile, which could be anywhere on the risk spectrum from very low risk to very high risk. An example of a very high risk might be the network hyper-risk across the entire food system as described by the analysis in the MBBF programme of work.

Existential risk – the risk of a fundamental, irreversible change in the performance of all systems relative to a specific perspective; for example, the existential risk to the survival of humans on Earth that is posed by the collective of risks associated with climate breakdown.

Topological map of risk through time (after Molly Jahn 2015) – a dynamic temporal and geospatial representation of risks at multiple scales including representation of the functioning of multiple complexes, non-linear, interlocking systems across all scales and the inter-linkages, dependencies, correlations and relationships among and across all types of risk (as broadly defined in the Sendai Framework, para. 15). The purpose is to provide an understanding of the current and future conditions on Earth to manage uncertainty through the

Multiple Breadbasket Failure: Climate shocks and consequent crop failure in one of the global cereal breadbaskets might have knock-on effects at the global level. The turbulences are exacerbated if more than one of the main crop-producing regions suffers from losses simultaneously – a scenario often described as multiple breadbasket failure (MBBF) (Fig 1.11)

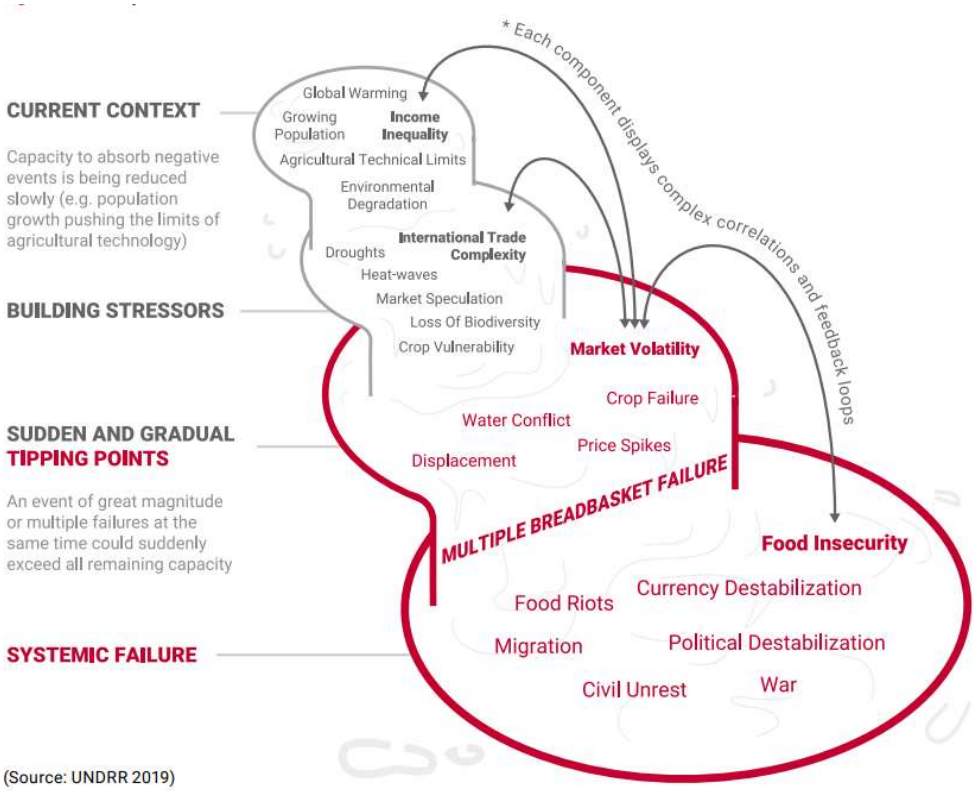

Fig 1.12: Multiple Breadbasket Failure

1.5.3 Disaster and Development

'Development' is a comprehensive social, economical and political process that aims at the constant improvement of the well being of the population and all individuals. Disasters and Development are interrelated and the relationship can be summarized as shown in Fig 1.13and Table1.7.

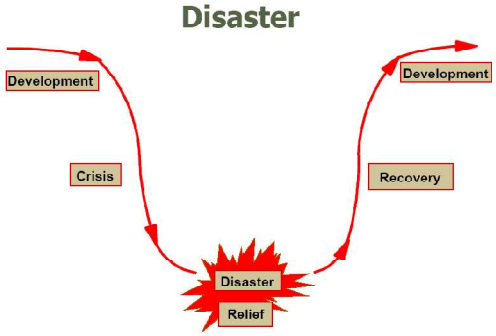

Fig 1.13: Relation between Development and Disaster

Source: http://ocw.jhsph.edu/courses/RefugeeHealthCare/PDFs/Lecture17.pdf)

Table 1.7: Disaster Vs Development

	Economic Development	***Social Development***
Disaster limits development	Destruction of fixed assets. Damage to transport, communication, infrastructure. Erosion of livelihood.	Destruction of health or education infrastructure and personnel. Death, migration of key social actors leading to an erosion of social capital.
Development causes disaster risk	Unstable development practices that create wealth for some at the expense of unsafe working or living conditions for others or degrade the environment.	Development path generating cultural norms that promote social isolation or political exclusion.
Development reduces disaster risk	Access to adequate drinking water, food, waste management and a secure dwelling increases people's resilience. Trade and technology can reduce poverty. Investing in financial mechanisms and social security can cushion against vulnerability	Building community cohesion, recognising excluded individuals or social groups, and providing opportunities for greater involvement in decision-making, enhanced educational and health capacity increases resilience.

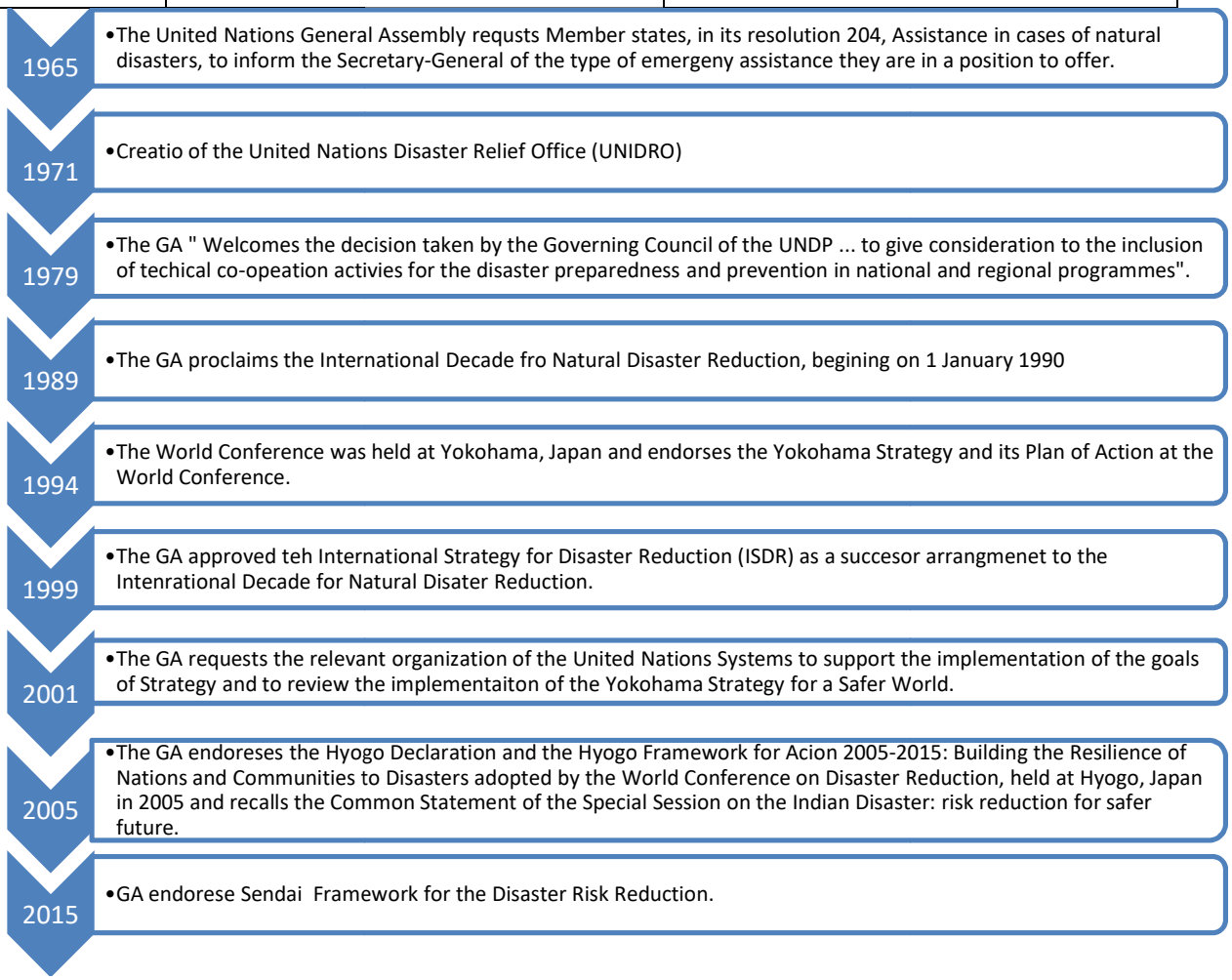

Fig 1.14: Evaluation of Disaster Management
(Source: Global Assessment Report, 2015).

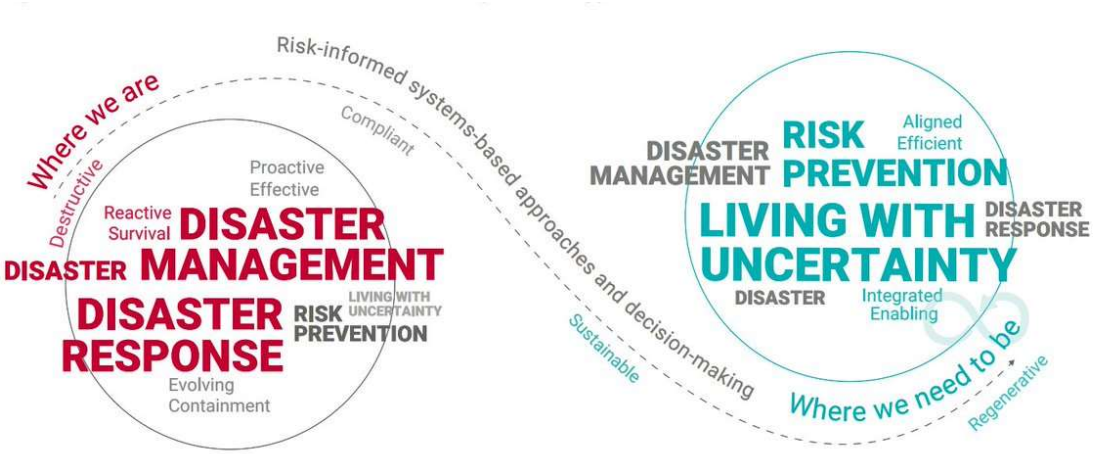

Fig 1.15: Innovation Curve – from Destructive to Regenerative Approaches
Source: UNISDR 2019

To Do Activity

- Profile the changes in the perception of Risk
- Describe the emergent risks and methods to prepare for the emergent risks.
- Present a description of changing perceptions of Risk in disaster management.
- Explain the impacts of disasters on development

Summary of Chapter

In this Unit, an explanation was provided about different elements that comprise risk, viz., hazard, exposure, Vulnerability, capacity. With this basic understanding, it is envisaged to enable the student to appreciate the need for systematic evaluation of these factors for better disaster management.

Model Questions

- What do you understand by Risk? Give suitable examples of elements at Risk in specific disasters your locality.
- Prepare a list of natural disasters, which are affecting your area **and** explain their impacts.
- Write a note on risk evaluation
- Discuss important vulnerability factors with illustrations.
- Distinguish Exposure and Vulnerability

Reading Materials

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Chapter 2 Types, Trends, Causes, Consequences and Controls of Disasters

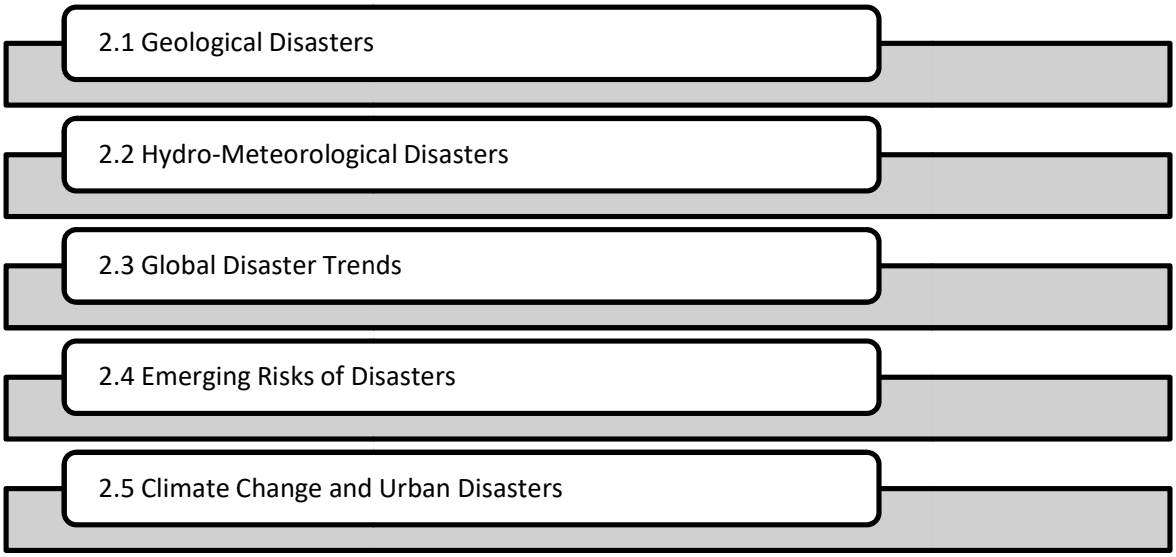
Introduction

A casual enquiry about incidence of an extreme natural event that might have effected a person in a very recent past or such an event happening in a region close to that person, is dependent onthe region that person hails from. If he is from the coastal region, the event would likely to be a cyclone or floods, if he is from interior parts, then it would be drought conditions, tremors or landslides if that person from the Himalayan belt. Similarly, a person from urban centres is likely to recollect the devastation of urban floods or heatwave. Similarly, a person from rural India would complain about drought conditions or floods damaging the crops. Likewise, a person, from any part of our country isis likely to recollect one or even more instances of natural extreme events, be it cyclone, drought, earthquake, floods, hailstorm, heat wave, landslide, lightening and soon. Itreflects vulnerabilityof our country exposed to extreme natural events also the tremendous loss to the economy and loss of life. This chapter presents abasic awareness about various disasters.

Objectives

On one hand, the number of people dying from natural disasters is declining, but at the same time, the number of people affected is increasing. On the economic front, disasters are causing large-scale economic damage - mostly as a result of floods, storms and droughts in India. For prevention of such colossal damages, preventive and adaptive measures are the key. To evolve most suitable measures for specific region and sector, understanding about the risk is required and chapter lays the basic introduction to various disasters.

Chapter Structure



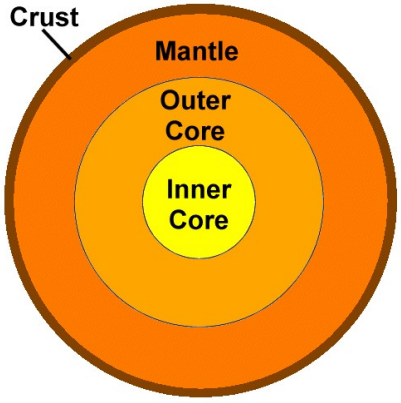
2.1 Geological Disasters

Geological or geophysical hazards have their origin in geological processes going on in the Earth, for instance, Earthquakes, Volcanic activity etc. These events are known to trigger secondary hazards such as landslides, tsunami etc.

2.1.1 Earthquake In simple terms, Earth is made up of different layers, namely, Crust, Mantle, Outer

Core and Inner Core, each layer getting denser as we go close to center. The crust is the outermost layer of the Earth. Its thickness is lowest in ocean floor (about 5 km) and is thickest on the continents (up to 70 km). Beneath the crust is the layer of Mantle. It is thicker than crust and extends up to 3000 km from the surface of Earth. Combination of crust and outer mantle is called tectonic plates and some are huge and cover entire continents. Earth surface consists of seven major plates (the African, Antarctic, Eurasian, North American, South American, India-Australian, and the Pacific plates) and about ten minor plates. These plates are constant movebutvery slowly and have three types of boundaries between them.

- Convergent Boundaries - Two tectonic plates push together. Sometimes one plate will move under the other, called subduction. These boundaries can be areas of geological activity such as the forming of mountains and volcanoes. They can also be areas of high earthquake activity. The Himalaya Mountain range was a result of the convergent boundaries of the Indian and the Eurasian Plates.
- Divergent Boundaries results where two plates are getting pushed apart and creating a rift and the new land is formed by magma pushing up from the mantle. The Mid-Atlantic Ridge is an example of such a boundary.
- Transform Boundaries occurs when two plates slide past each other. These places are often called faults and can be areas where earthquakes often occur.



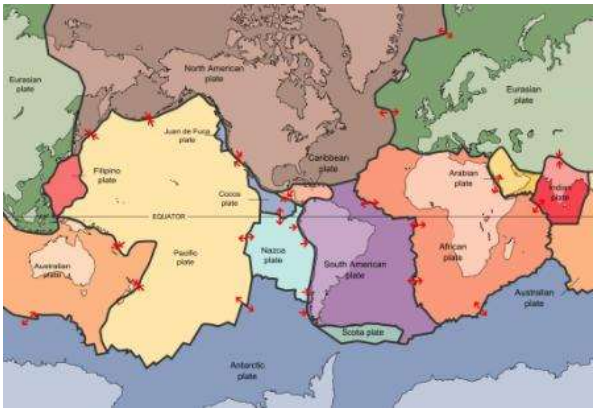


Fig 2.1: Simplified Structure of Earth **Fig 2.2: Major Tectonic Plates of Earth (Source: https://en.wikipedia.org/wiki/List_of_tectonic_plates)**

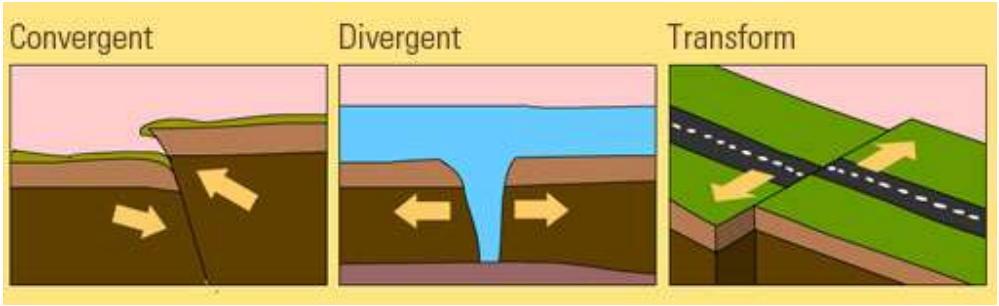


Fig 2.3: Types of Tectonic Boundaries

(Source:https://www.researchgate.net/profile/Joao_Duarte9/publication/305782020/figure/fig1/AS:508759652790272@1498309161471/Schematic-representation-of-the-three-types-of-plate-boundaries-convergent-top.png)

As the tectonic plates move, the edges of faults are stuck together, butthe rest of the Chapter is

moving.Energy that would normally cause the Chapters to slide past one another is being stored up and the stress accumulates until it exceeds the friction of jagged edges of the fault. It unsticks suddenly, releasing all energystored in all directions in two waveforms, viz., body or primary waves (P) and surface waves (S). Under P-waves, material undergo extensional and compressional strains along the direction of energy transmission. Under S-waves,theyoscillate at right angles to it. Sometimes an earthquake has foreshocks. These are smaller earthquakes that happen in the same place as the larger earthquake that follows. The Intensity or magnitude of earthquakes are recorded by seismographs.andthe recording is called a seismogram. If the earthquake takes place in a populated area, itmay cause numerous casualties and injuries as well as extensive damage to property.

P-Waves (Primary Waves) S- Wave (Secondary Waves)

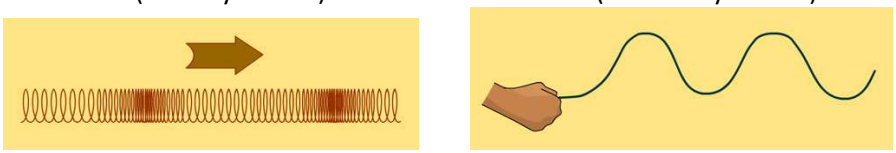


Fig 2.4: Mode of Propagation of P and S Waves

2.1.1.1 Risk Mitigation Measures Till recently, entire Himalayan belt is considered prone to earthquakes, while, other regions of the country, away from inter-plate boundaries were considered to be relatively safe from earthquakes. Based on this past profile of earthquakes, the country was divided into five zones - I, II, III, IV and V (1970 version). The maximum Modified Mercalli (MM) intensity of seismic shaking expected in these zones was V or less, VI, VII, VIII, and IX and higher. But, incidences ofdevastating earthquakes, for instance, the Koyna earthquake in 1967, the Killari earthquake in 1993 have resulted in further revision of the seismic zoning map of the country. The non-seismic zone was removed and the low hazard zone or Seismic Zone I was merged with Seismic Zone II and accordingly, the revised map of 2002 has only four seismic zones - II, III, IV and V.

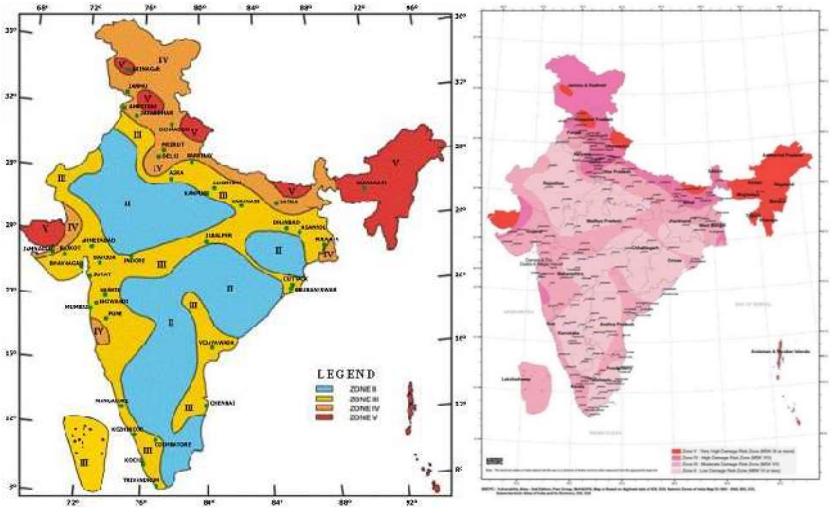


Fig 2.5: Earthquake Vulnerability Map of India (Revised in 2002)
Source: NDMA Guidelines on Earthquake

Though with existing scientific knowledge, it is not currently possible to make deterministic predictions of when and where earthquakes will happen, some countries like Japan, Taiwan, have developed Early Earthquake Warning Systems (EEW),that can raise an alarm a few seconds to tens of seconds warning prior to ground shaking during an earthquake, but, the prediction of the earthquake still a subject of speculation.

A building, when struck by an earthquake, is thrown mostly from side to side, and also up and down along with the building foundation while the building structure tends to stay at rest, in a way similar to a passenger standing on a bus that accelerates suddenly. This differential movement results in damage to the structures and extent of damage depend on the building characteristics, the duration and severity of the earthquake.

Plate 1: Apartment Building Damaged in Surat and Ahmadabad during the Kutch Earthquake 2004.(Source: NDMA)

Fig 2.3: Damaged Bus stand near to Epicenter of Earthquake Damaged Railway line
(Source: Pramod K. Mishra., 2012)

- **Structural Measures**: Earthquake, on its, do not cause any damage but the physical structures like buildings, pipelines, roads, railway lines are unable to withstand the propagation of P and S waves through their structures and they get damaged and may collapse. It is the falling debris of the buildings which tend to cause maximum injuries and life loss. Though no building can be made full proof to earthquakes, by incorporating required structural amendments, a building can be made earthquake resistant to some extent.
- **Non-Structural Measures** involve the awareness programmes to masons about to the need to incorporate earthquake-resistant features to houses, depending on that region's vulnerability.

2.1.2 Landslides: landslide is a general term used to describe the downslope movement of soil, rock, and organic materials under the effects of gravity and also the landform that results from such movement. It is the most common and universally accepted collective term for most slope movements of the massive

nature. This sudden movement of material causes extensive damage to life, economy and environment. The term has sometimes been considered unsuitable as the active part of the word denotes sliding, whereas it connotes even movements without sliding like fall, topple, flow etc.

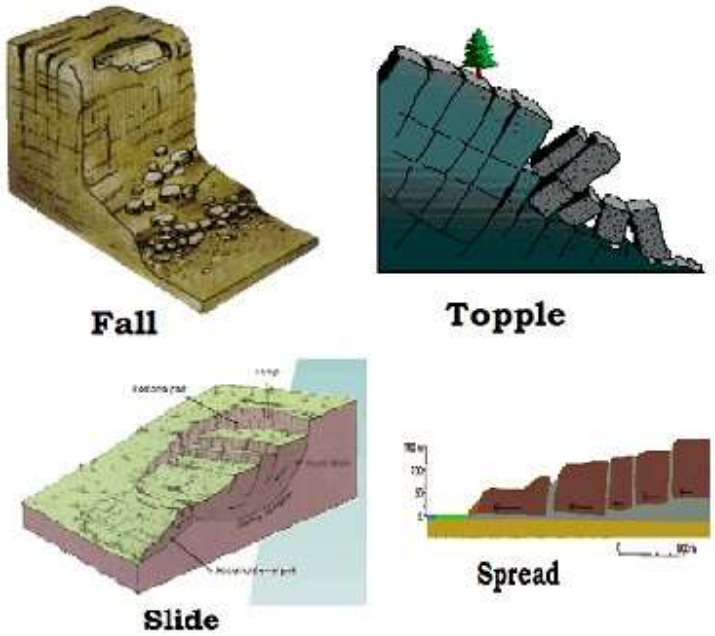


Fig 2.6: Type of Landslide
(Source: ADPC Net)

Based on process types, there are five types of landslides i.e. Fall, Topple, Slide, Spread, Flow and Subsidence.

- **Fall**: is very rapid to an extremely rapid movement which starts with a detachment of material from steep slopes such as cliffs, along a surface on which little or no shear displacement takes place. The material then descends through the air by free-falling, bouncing or rolling onto the slopes below. Movement is very rapid to extremely rapid.
- **Topple**: involves overturning of material. It is the forward rotation of the slope mass about a point or axis below the centre of gravity of the displaced mass. Topples range from extremely slow to extremely rapid movements. Generally, driven by gravity and sometimes by water or ice in cracks in mass.
- **Slide**: movement of material along recognizable shear surface e.g. translational and rotational slides. The downslope movement of soil or mass occurring dominantly on surfaces of or on relatively thin zones of intense shear strain. The sign of ground movement are cracks of the original ground.
- **Flow**: is a landslide in which the individual particles travel separately within a moving mass. Spatially continuous movement, in which surfaces of shear are shortlived, closely spaced and usually not preserved. Flows are differentiated from slides, on the basis of water content, mobility and evolution of the movement.

Plate 3: Landslides
Source; NDMA

The Himalayas, the highest mountain chain on earth, are formed due to collision of Indian and Eurasian plate. The continuous northward movement of the Indian plate (about 5 cm/year) towards China results in stress and make it prone to landslides and earthquakes. Besides the Himalayas, the Northeastern hill ranges, the Western Ghats, the Nilgiris, the Eastern Ghats and the Vindhyans, in that order, covering about 15 per cent of the landmass are also vulnerable to landslides. The Northeastern region is also badly affected by landslides. In sum, Landslides result in chronic problems, causing recurring economic losses worth billions of rupees.

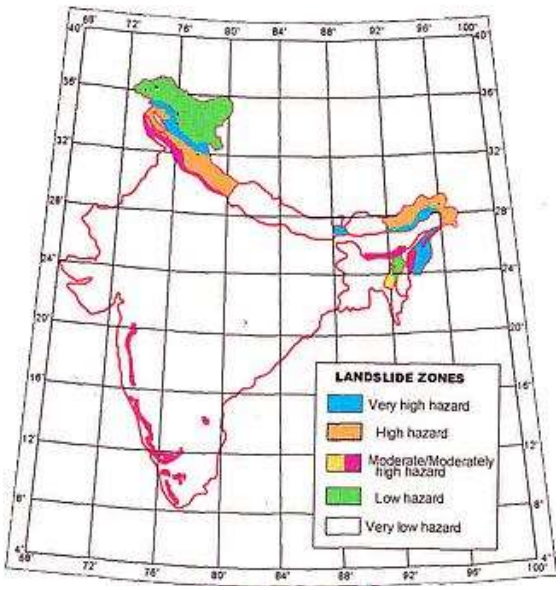


Fig 2.7: Landslide Vulnerability Map of India (Source: NDMA)

2.1.3 Tsunami A Tsunami generally is generated by any disturbance that displaces a large water mass from its equilibrium position. For instance, the incidence of an earthquake on sea-bed results in sudden uplift or subsidence of seafloor, disturbing the water column above. Similarly, collapses of volcanic structures or eruption of submarine generate an impulsive force that generates a tsunami. Conversely, Supermarine landslides impacts disturb the water from above, as momentum from falling debris is transferred to the water into which the debris falls. Tsunamis generated from these mechanisms dissipate quickly. The tsunami's energy flux, which is dependent on both its wave speed and wave height, remains nearly constant. Tsunamis can travel up to 965 km per hour or 521 knots at the deepest point of the water, but slow as they near the shore, eventually hitting the shore at 48 to 64 kph. As the tsunami enters shallow water, its speed diminishes but its height grows and as it reaches the coast, resulting in deadly devastation.

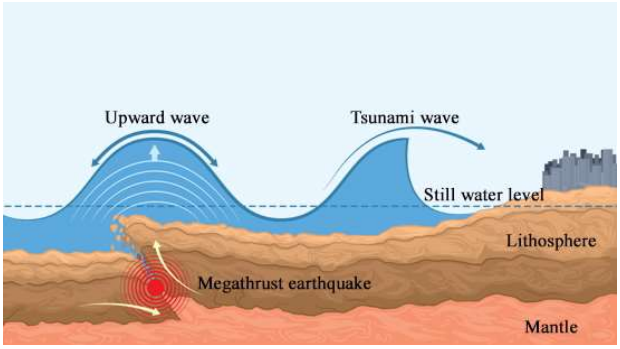


Fig 2.8: Formation of the Indian Ocean Tsunami

To Do Activities

- Explain the geological disasters happened in South Asia during recent past and list mitigation measures that individual household can implement at their level.
- Please explain the structural measures that could reduce the damages due to earthquakes
- Landslides are becoming more frequent in tourist places – please expand with relevant factors

2.2 Hydro-Meteorological Disasters

Hydro-meteorological hazards have their origin in atmospheric, hydrological or oceanographic components of earth. For instance, cyclones have their sources in the ocean while drought has its origin to the atmospheric component. These hazards have the capacity to exaggerate the intensity of other hazards.

2.2.1 Cyclone Driven by gravity, wind (Coriolis Effect), and density, water in Oceans move constantly. The movement of Ocean water moves is in two directions: horizontally and vertically. Horizontal movements are referred to as currents, while vertical changes are called upwellings or downwellings. Ocean currents are the continuous, predictable and they transport and redistribute heat and salt.It plays an important role in driving the Earths planetary climate engine. When two currents with different temperatures come in contact, the difference between the warm and the cooler environment led to the movement of air. The warm air on warm current becomes buoyant and moves to upward creating low pressure. The cool air from cooler current fills the air in the low-pressure area. This cycle continues as warm air rises and a low-pressure area filled with cool air. They build up over a period of time. The warm air as it moves up, it gets cooled and water within it cools and forms clouds. The whole system of clouds and wind spins and grows, fed by the ocean's heat and water evaporating from the ocean surface leads to a cyclone. It will begin to weaken as soon as its source of warm moist air begins to ebb, or is abruptly cut off. This happens after its landfall or when it passes over cold waters. Speed of wind differs in different stages in the formation of the cyclone and also the destructive power (Table 2.1).

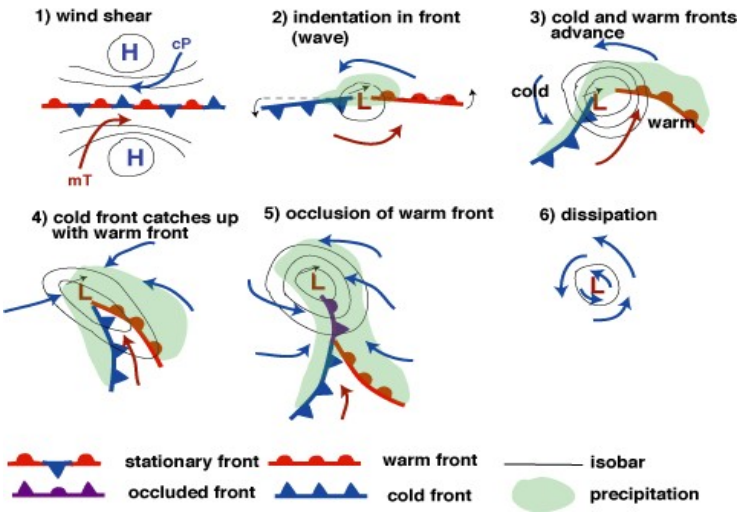


Fig 2.9: Stages in the Formation of Cyclone

Table 2.1: Typical Wind Speeds

Type of Disturbances	Wind Speed in Km/h
Low Pressure	Less than 31
Depression	31-49
Deep Depression	49-61
Cyclonic Storm	61-88
Severe Cyclonic Storm	88-117
Super Cyclone	More than 221

Table 2.2: Potential Destructive Power

Cyclone Category	Wind Speed in Km/h	Damage Capacity
01	120-150	Minimal
02	150-180	Moderate
03	180-210	Extensive
04	210-250	Extreme
05	250 and above	Catastrophic

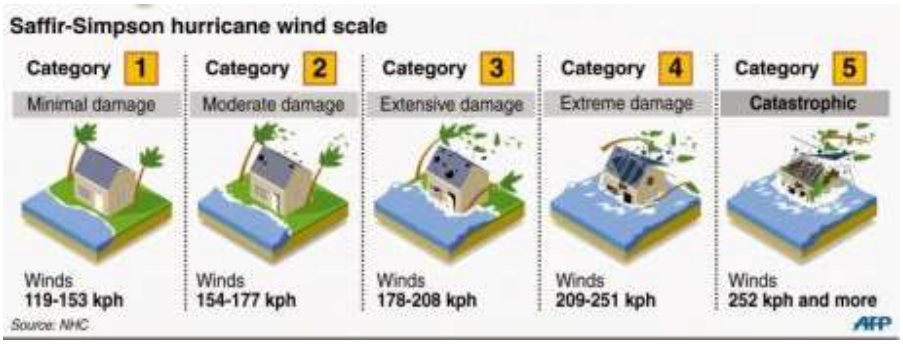


Fig 2.10: Destructive Power of Wind

The Indian subcontinent is exposed to nearly tenper cent of the world's tropical cyclones. On an average, India has to bear with about five to six cyclones in a year and the majority of them occur in East coast, in the months of May-June and October-November. With a long coastline of 8041 KM, 13 coastal states and Union Territories (UTs), are affected by tropical cyclones. Four states (Tamil Nadu, Andhra Pradesh, Orissa and West Bengal) and one UT (Puducherry) on the east coast and one state (Gujarat) on the west coast are more vulnerable to hazards associated with cyclones. About eight per cent of the area of the country and about 32 crores of the Indian population are vulnerable to the cyclones (NDMA …..). In order to mitigate the adverse impacts of cyclones, Government of India has adopted three major strategies, viz., Improvement of early warning dissemination system by strengthening the Last Mile Connectivity (LMC) of cyclone warnings and advisories, 2) Cyclone risk mitigation investments and 3) hazard risk management and capacity building. These efforts have brought down the death rateto a great extent during the cyclones.

2.2.2 Floods represent a situation when an overflow of water submerges an area that is generally dry. There are three common types of floods:

- **Flash floods** are caused by rapid and excessive rainfall that raises water heights quickly, and rivers, streams, channels or roads may be overtaken.
- **River floods** are caused when consistent rain or snowmelt forces a river to exceed capacity.
- **Coastal floods** are caused by storm surges associated with tropical cyclones and tsunami

Depending on their intensity, floods can cause widespread devastation, loss of life and damages to personal property and critical public health infrastructure. Between the year 1998-2017, it has been estimated that floods have affected more than 2 billion people worldwide. Floods can also have medium- and long-term health impacts, including:

- water- and vector-borne diseases, such as cholera, typhoid or malaria
- injuries, such as lacerations or punctures from evacuations and disaster cleanup
- chemical hazards
- mental health effects associated with emergency situations
- disrupted health systems, facilities and services, leaving communities without access to health care
- damaged basic infrastructure, such as food and water supplies, and safe shelter. (https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health)

Abouteighty per cent of the yearly precipitation occurs in just four months, from June to September. From catchment, along with runoff water, the rivers bring heavy sediment load also. Factors likeinadequate carrying capacity , drainage congestion,erosion of river-banks result infloods. Out of the

total geographical area of 329 million hectares (mha), more than 40 mha in the country is flood-prone and results in huge loss of lives and damage to livelihood systems, property, infrastructure and public utilities every year. The average annual loss from floods in the country is estimated to be US$ 7.4 billion (UNISDR 2015) (Global Assessment Report on Disaster Risk Reduction 2015, UNISDR).

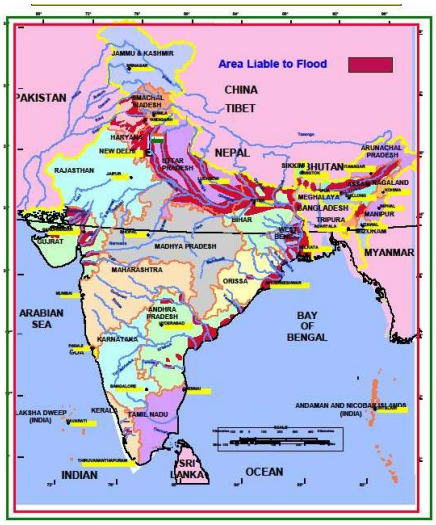


Fig 2.11: Area vulnerable to Floods (source NDMA)

Flood Mitigation measures by the government fall into the following categories.

- Ensuring the effectiveness and sustainability of existing structures
- Continuous flood forecasting with early warning and decision support systems
- Flood preparedness in design for new structures
- Improving awareness and preparedness in all stakeholders
- strengthening emergency response capabilities

2.2.3 Urban Flood Urban flooding is not just "flooding that happens in an urban area." It is not caused when a river overflows. Rather, it' is the result of excessive runoff generated even during a small amount of rain. In overdeveloped areas,there is no scope for the water to percolate and results in flash urban floods. Three components that result in urban flooding, viz.,

- Heavy Precipitation event,
- Impervious surface. and
- Inadequate stormwater drainage capacity

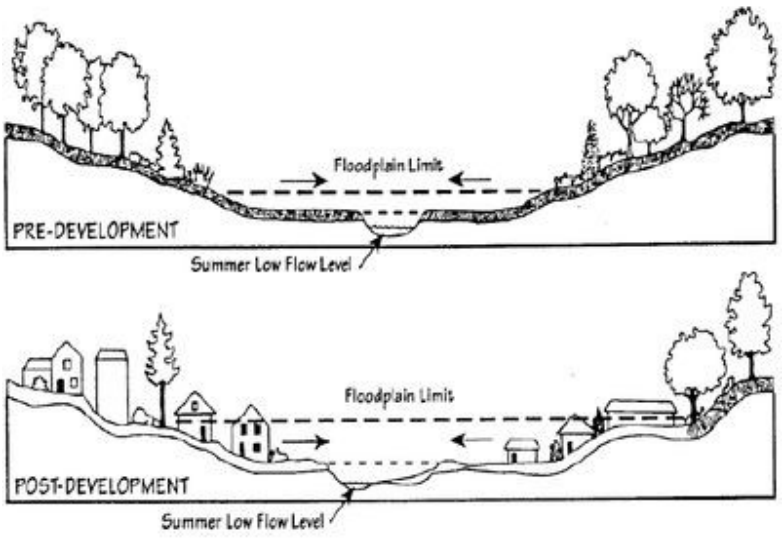


Fig 2.12: Change in the Floodplain due to Development
(Source: Ramachandra et al 2009)

Table 2.3: Some Major Incidents of Urban Floods

City	Flooding Events	Losses
HYDERABAD Capital of Telangana. The city's population is 6.7 million and a metropolitan population of 7.7 million (2011 Census). The city is located on the banks of river Musi and is an established IT and knowledge hub of India.	• August 1954 • 1970 • August 2000 (240mm in one day and 469mm total rainfall) major flood • August 2001 • August 2002 • 2006 • August 2008 (220.7mm in 36 hours)	In 2000 floods damaged 35,693 homes worth Rs.135 lakhs and affected 2 lakh people. In the year 2008, floods affected 1.5 lakh people
DELHI, Capital city of India, and with a population of 22 million in 2011 (area 33578km2 as per NCRPB), it is the world's second-most populous urban agglomeration. Delhi's population is 16.8 million and it has an area of 1483 km2. River Yamuna is a major water body in the city.	• 1977, 1978, 1988, 1995, 1998 • 2010 (water level in the Yamuna had crossed the 207 m mark), 2011 • 2013 (117.8 mm in four and half hours) • 31st July 2016 (62mm rain in 3 hours)	In 1978, the total damage to crops, houses and public utilities was estimated at Rs.176.1 million; In 1988, floods affected approximately 8,000 families; In 1995, floods rendered approximately 15,000 families homeless In 2016, an extreme heavy spell of rainfall created city-wide traffic jam at morning office hours.

CHENNAI At 7.6 % decadal growth of population, Chennai is one of the fastest-growing metropolitan cities in India. The metropolitan area has a population of 8.6 million as per Census 2011 (7.08 million in the city). The geographical area of Chennai metropolitan area is 1189 km2, while the city area is 426 km2. Adyar and Cooum Rivers are the main river of the city.	• 2004 • 2015 (Mega Floods in November and December)	New developments in southern and western Chennai flooded. Rail and Air services disrupted. Floods claimed 280+ lives in Chennai and more than 1,27,580 people rescued. All schools, colleges, offices, AUTO and IT companies were closed. Assocham reported a loss of Rs. 15,000 crore (CNBC)
MUMBAI Is the financial capital of India. The metropolitan population is 20.7 million (12.4 million population of Mumbai city). The decadal growth rate (2001-11) of Mumbai city was 4.2%. The metropolitan region of Mumbai is 4355 km2, while the city covers an area of 603 km2. Meethi river, Powai lake, Vihar lake, Tulsi lake are main water bodies within the city.	• July 2005 (944mm of rain in 24 hours)- Mega Floods • 2007 • 2015 (300mm rainfall in 24 hours)	In 2005 floods, 1094 lives lost, all major suburbs affected, train services, buses, airport operations suspended (for about 30 hours); Loss of Rs. 550 crores in two days.
BANGALURU is the 'IT city' or 'silicon valley' of India due to the presence of several software companies. Bangaluru is the 5th largest metropolitan region of India with a population of about 8.52 million. Bangalore's population registered a decadal growth of 46% between 2001-11. Bangalore's city population is 8.4 million and it covers an area of 741 km2.	• October 2005 (525 mm in 24hours) • 2009, 2013 • July 2016 (38 mm rain in 24 hours, 96 mm rain in 72 hours)	In 2005, 100 homes were damaged and 54 collapsed, 10 persons died. Schools and colleges were closed. WIPRO and Hinduja TMT offices were flooded. In July 2016, 38 mm rainfall in just 24 hours on 28th July led to overflowing of lakes which flooded the city, particularly IT hub in south-east Bangaluru. The rainfall inundated all arterial roads up to 3 feet, cars submerged, trees uprooted, and traffic snarls reported.
SRINAGAR is the summer capital of Jammu and Kashmir and is also the largest city in the state. It is a popular tourism destination in Kashmir valley. The population of Srinagar urban agglomeration was 12,73,312 (as per census 2011). Jhelum river, Dal lake and Wular lake are main water bodies in the city.	• 1950, 1957, 1959 • September 1992 (151 mm rainfall in 24 hours) • 2-6 September 2014 (a breach in the levee of river Jhelum)	In 1992 floods, 200 people lost their lives, 60,000 marooned In 2014, floods affected the entire Kashmir valley (including the city of Srinagar). Srinagar inundated as river Jhelum crossed the danger mark. Water was as high as 12 feet in many neighbourhoods of Srinagar. The preliminary estimate of damage was Rs. 5000-6000 crores. The city administration, transport, telecommunication and hospitals operations were affected.

Source: NIUA 2016)

2.2.4 Drought A drought can be short-lived, as few as 15 days or can last for months or years, having a substantial effect on the agriculture, human population, livestock and ecosystem in the affected region (NDMA, 2010). The small and marginal farmers, who are already facing food and livelihood insecurity

experience the deleterious effects of drought (UNICEF, 2016). Seven types of droughts are recognized in India (DAC&FW 2016, NDMA 2010), viz.,

- Meteorological Drought - short-lived but usually precedes all other kinds of droughts;
- Hydrological Drought - If the runoff is less than 75% of the normal and results in a shortage of water supplies in surface and sub-surface;
- Agricultural Drought - Meteorological and hydrological droughts usually trigger this type. It directly impacts the crop yields. Itis defined as a period of four consecutive weeks (of severe meteorological drought) with a rainfall deficiency of more than fiftyper cent of the long-term average or with a weekly rainfall of five cm or less from June to September. About 80 per cent of India's total crop is planted during this period. or six such consecutive weeks during the rest of the year (called as Rabi season);
- Soil Moisture Drought - water supply to soil profile is lower, and the evaporative demand is more due to high temperature & winds with low relative humidity;
- Socio-economic Drought - reduction in the availability of food/income loss due to the failure of crops. This affects the socio-economic fabric of the society and leads to compulsive migrations from village to cities in search of greener pastures for their food and livelihood;
- Ecological Drought - This affects the ecosystem, eco-environment and its production system significantly as a consequence of distress induced environmental damage; and
- Famine: If droughts prolong for more extended periods, there will be substantial scale deficiency of food/feed/water that leads to significant scale mass starvation causing deaths.

Droughts and its Consequences: Droughts can have significant environmental, agricultural, health risks, economic and social consequences. The effect on society depends onits vulnerability. Marginal and subsistence farmers migrate since they lack alternative income sources. Drought can also deterioratewater quality . Drought canalso result in;

- Too less water to support crops.Diminished crop yields and milk/meat products from livestock.
- Lack of water for drinking, irrigation and industrial users.
- Damage to eco-system.
- Hunger, its related deaths
- Malnutrition related diseases.
- Mass migration, resulting in internal migrations
- Reduced hydroelectric production.
- Social unrest, conflict over natural resources,
- Forest fires and low groundwater levels.

Indian agriculture is dependent on south-west monsoon (from June to August) to a large extent. If the monsoon is normal, the majority of the reservoirs of Maharashtra, Karnataka, Telangana, Andhra Pradesh, Tamil Nadu and Kerala can be considered having a good harvest. But, Drought disturbs the family life, derails the process of development, and forces children into labour, early marriage and migration. Drought being the slow onset of disaster, which could be managed better provided all stakeholders adhere to early warning, adapt toalternative measures/crops and other relevant mitigation measures.

Though state governments and civil society actors are responding to drought situations, by providing relief in the form of drinking water, food grains, cash for work (MGNREGS) and cattle camps, it is also important to understand the impact of recurring drought and the drought-like situation on the communities as well as development programs, especially programs for infants, pregnant women, lactating mothers, adolescent girls, school-going children and elderly. According to government sources

and media, droughts have caused severe out-migration, distress sale of assets like livestock and even some instances of farmers' suicides in drought-affected regions. Government of India has identified 16 districts in Karnataka and some are grouped under Aspirational Districts, some under NITI Ayog Districts for development. UNICEF has identified some districts for program intervention by it in specific areas of WASH, Nutrition, Education, Health and Child Protection.

Drought has its implications on several aspects such as infant mortality, maternal mortality, malnutrition among children and women, high incidence of childhood diseases, inadequacies in water supply and sanitation. Ultimately result in a low Human Development Index (HDI) ranking (Shivashankar and Ganesh Prasad, 2015, PPMSD 2014). Due to a very low HDI, some districts are categorized as Aspirational Districts by the Government of India (NITI 2018 a & b) with some of these identified by UNICEF for their intervention in the areas of Health, Education, Nutrition and Water & Sanitation and Child Protection as well (UNICEF 2016). An in-depth understanding about direct and indirect impacts of drought on children, their health, nutrition, protection, education and other related issues may provide insights for concerned stakeholders to devise an effective recovery, mitigation measures and intervention for achieving long-term climate and disaster resilience.

2.2.5 Heatwave If the ambient temperature remains at 37° C, there will be no impact to the human body but, it the environmental temperature increases above 37° C, the human body starts gaining heat from the atmosphere. If humidity is high, it may lead to heat stress disorders even with the temperature at 37°C or 38°C ashigh humidity do not permit the loss of heat from the human body through perspiration, and Heat Wave conditions can be said to be formed. Higher the temperature and humidity, the stress will be more on the human body and it may even lead to death, various intermediate states are likely to be as follows.

Table 2.4: Symptoms of Heat Stroke

Heat Disorder	Symptoms	First Aid
Heat rash	Skin redness and pain, possible swelling, blisters, fever, headaches.	Take a shower using soap to remove oils that may Chapter pores preventing the body from cooling naturally. If blisters occur, apply dry, sterile dressings and seek medical attention.
Heat Cramps	Painful spasms usually in leg and abdominal muscles or extremities. Heavy sweating.	Move to a cool or shaded place. Apply firm pressure on cramping muscles or gently massage to relieve spasm. Give sips of water. If nausea occurs, discontinue.
Heat Exhaustion	Heavy sweating, weakness, skin cold, pale, headache and clammy extremities. Weak pulse. Normal temperature is possible. Fainting, vomiting.	Get the victim to lie down in a cool place. Loosen clothing. Apply cool, wet cloth. Fan or move victim to air-conditioned place. Give sips of water slowly and if nausea occurs, discontinue. If vomiting occurs, seek immediate medical attention, call for medical assistance
Heat Stroke (Sun Stroke)	High body temperature. Hot, dry skin. Rapid, strong pulse. Possible unconsciousness or altered mental status. The victim will likely not sweat.	Heatstroke is a severe medical emergency and needs medical attention. Try a cool bath or sponging to reduce body temperature. Use extreme caution. Remove clothing. Use fans and/or air conditioners.DO NOT GIVE FLUIDS ORALLY if the person is not conscious.

The heatwave is defined as a condition of atmospheric temperature that leads to physiological stress, which sometimes can cause deaths as well. The World Meteorological Organization defines a heatwave as five or more consecutive days during which the daily maximum temperature exceeds the average maximum temperature by five degrees Celsius. In India, a heatwave is considered if maximum temperature of a station reaches at least 40°C or more for plains, 37°C or more for coastal stations and at least 30°C or more for hilly regions and following criteria are used to declare a heatwave (NDMA 2017).

a) Based on Departure from Normal	*Heat Wave:* Departure from normal is 4.5°C to 6.4°C
	Severe Heat Wave: Departure from normal is >6.4°C
b) Based on Actual Maximum Temperature (for plains only)	*Heat Wave:* When actual maximum temperature ≥ 45°C
	Severe Heat Wave: When actual maximum temperature ≥47°C

To declare a heatwave, the above criteria should be met at least at two stations in aMeteorological sub-division for at least two consecutive days. A heatwave will be declared on the second day. Following preventive measures were suggested by NDMA.

- **Cool Roofs to Provide Affordable Thermal Comfort:** A cool roof is a white reflective roof that stays cool in the sun by minimizing heat absorption and reflecting thermal radiation to help dissipate the solar heat gain. Studies have shown that cool roofs can be up to 30° C cooler than conventional roofs, and can bring the indoor temperatures down by 3-5° C. If adoptedon a large scale, cool roofs can reduce the urban heat island effect in a city also.
- **Livestock preparedness during hot weather:** Extreme heat causes significant stress to livestock. There is a need to plan well for reducing the impacts of high temperatures on livestock. Keeping an eye on the weather forecasts, and developing a mitigation plan for high to extreme temperature can be effective in ensuring that the livestock has sufficient shade and water on hot days.

To Do Activities

Explain the rapid and slow onset hydro-meteorological disasters and their adverse impact on agriculture
Drought – a creeping disasters: please describe and give the measures to mitigate its impacts.
Why the Heatwave is called as Silent Killer?

2.3 Global Disaster Trends

Natural Disasters, based on their impact can be divided into two categories , viz., low frequency but high impact such as earthquakes, tsunami, and b) High frequency with low impact, viz., cyclone, floods etc. We can not prevent a majority of the natural disasters, but, factors like earlier prediction, more resilient infrastructure, emergency preparedness, and response systems help in reducing the loss of life significantly as reflected in global trends of mortality rates. .

Mortality details due to natural disasters during 1978 till 2018 is shown in Fig and it indicates that on average, the global mortality rate is below ten thousand, but there are few disasters that have spike the death rate by several folds. The 1983-85 famine and drought in Ethiopia; the 2004 Indian Ocean earthquake and tsunami; Cyclone Nargis which struck Myanmar in 2008; and the 2010 Port-au-Prince

earthquake in Haiti are recent notorious events and these events pushed global disasters deaths over 200,000 – more than 0.4% of deaths in these years. These data indicate the necessity of adequate attention to the measures to prevent these losses.

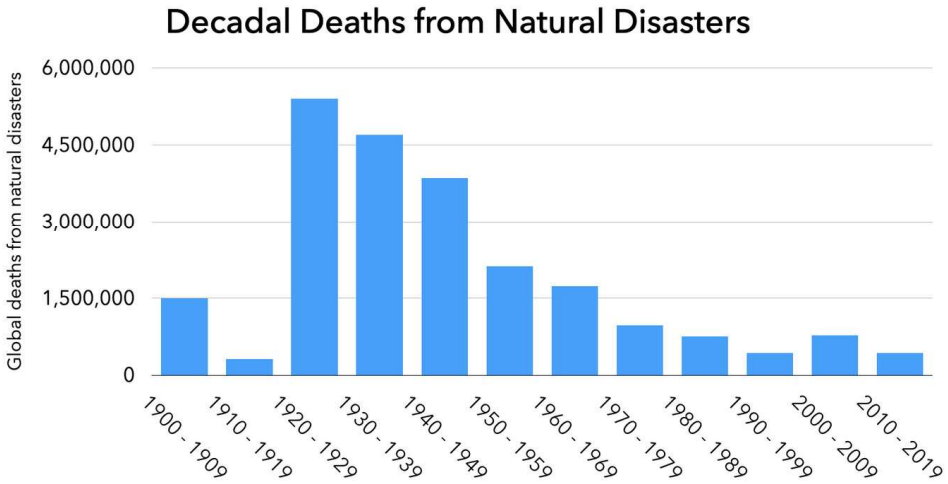


Fig 2.13: Global Deaths from Natural Disasters

Source; EMDAT 2020

Loss of life caused by the natural disasters as a share of total mortality rate for the world and India during the period from 1990 to 2017 and from the year 2000 to 2018 is shown in fig. 2.13.. With the exception of years of severe disasters, the share of natural disasters in total deaths is less than 0.1 per cent and most importantly, the share is coming down from the beginning of this century. It indicates the effectiveness of disaster management measures in reducing the death rate due to natural disasters.

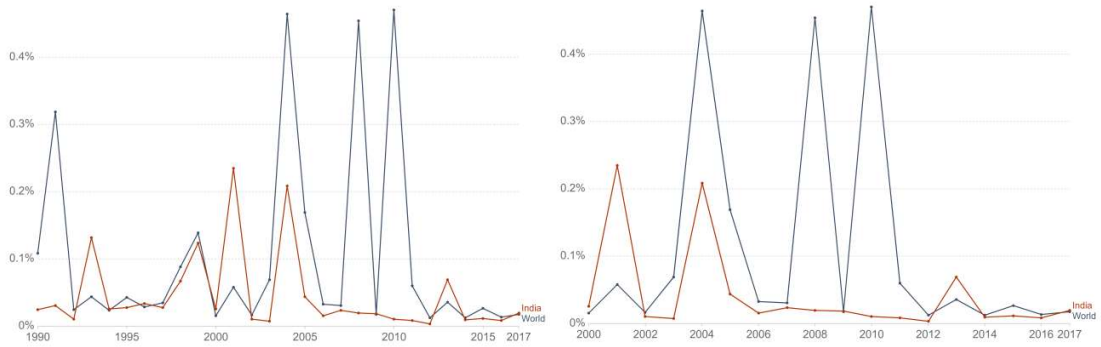


Fig 2.14: Deaths from Natural Disasters as a Share of Total Deaths in the World and India, a) from 1990 to 2017, b) from 2000 to 2018

(Source: Institute of Health Metrics and Evaluation (IHME), 2018)

Global share of natural disasters in total deaths during the year 2017 is shown in Fig. 2.14 and it clearly emerges that majority of the countries with higher share of natural disasters in total deaths happens to be developing economies and it strongly indicates the linkages between the poverty and vulnerability to the natural disasters.

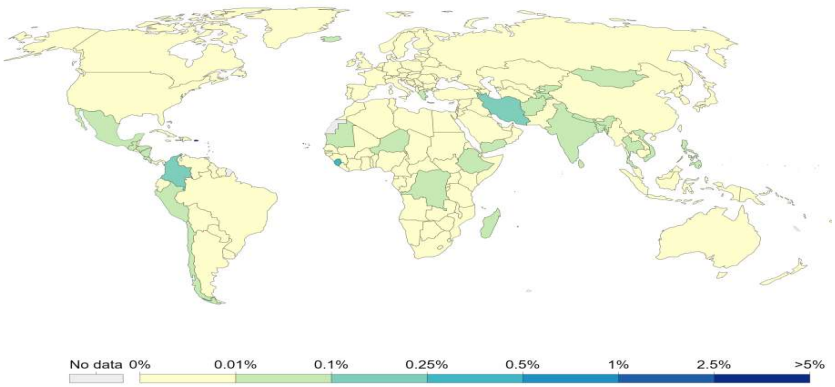


Fig 2.15: Global Deaths from Natural Disasters as a Share of Total Deaths, 1990 to 2017
(Source: IHME 2018)

2.3.1 Number of Deaths by Type of Natural Disaster The death rate due to natural disasters from the year 1900s is given in figure 2.15, and the data during recent past, it was large earthquake events that took higher death toll, and followed by the indicates that (Fig 2.16) hydrological disasters drought and floods have caused larger death among the natural disasters. Earthquake, though less frequent than hydrological disasters have also resulted in significant deaths. However, with the exception of low frequency, but high impact events, the loss of life is declined.

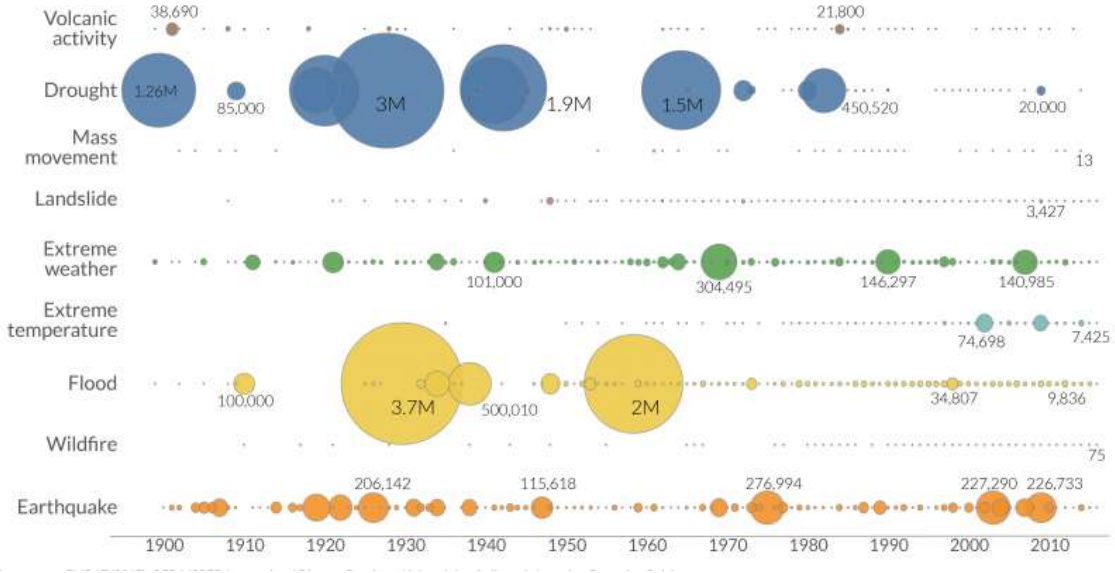


Fig 2.16: Deaths Caused by Different Types of Natural Disasters
Source: EMDAT 2017

Mortality in Landslides As we would expect, the risks of landslides are much greater close to high mountainous regions with dense neighbouring populations. This makes the mortality risk highest across the Andes region in South America and the Himalayas across Asia.

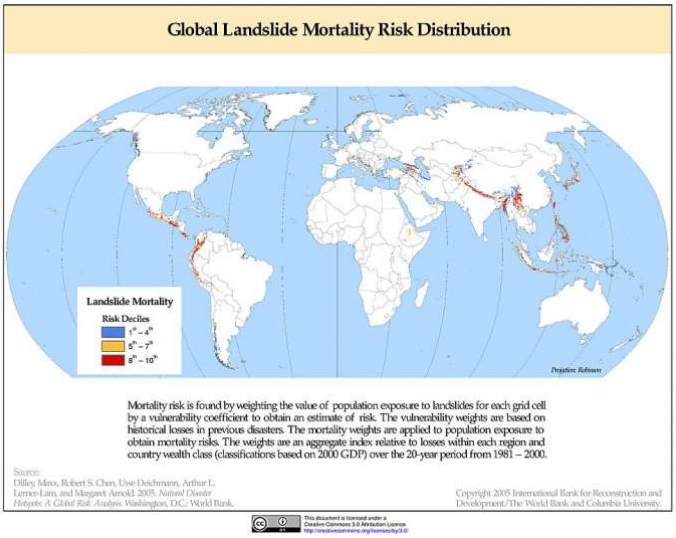


Fig 2.17: Global Landslide Mortality Risk Distribution – SEDAC (NASA)7

Lightning: expressed in terms oftheLightning Strike Density (the average strikes per square kilometre each year), the Fig 2.18shows the distribution of lightning strikes across the world. High frequency of strikes across the Equatorial regions, especially across central Africa.

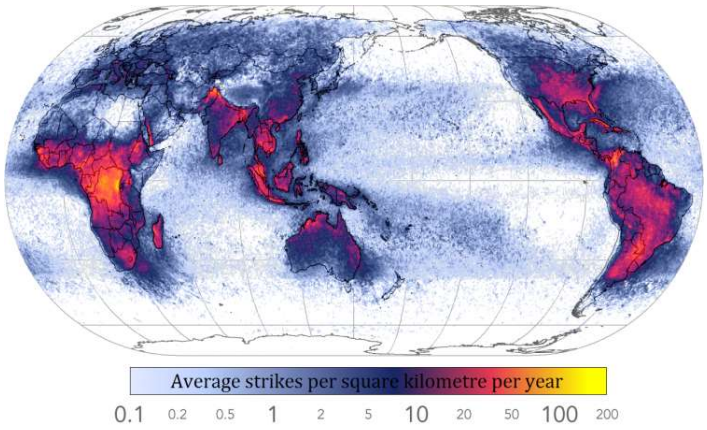


Fig 2.18: World map of frequency of lightning strikes – Wikipedia (NASA data)8

2.3.2 Global Disaster Costs

In addition to the loss of life, every natural disaster extracts a heavy price in terms of economic loss. One cansee a pattern of the rising value of losses due to disasters, but it does not reflect the growing economy. For instance, global Gross Domestic Product (GDP) has increased about four times from 1970 and hence, every successive disaster, even if it is of similar intensity, is likely to cause losses higher than previous disasters. Hence, for a comparison of economic losses due to natural disasters over time, a more appropriate approach could be is to compare the economic losses in relation to GDP. A more appropriate metric to compare economic costs over time is to look at them in relation to GDP and Fig 2.19 presents the global direct disaster losses given as a share of GDP. A significant variation can be seen from year to year and that there is no trend over the years. As can be seen, in the years with severe disasters, the losses were shot up to 0.5 per cent.

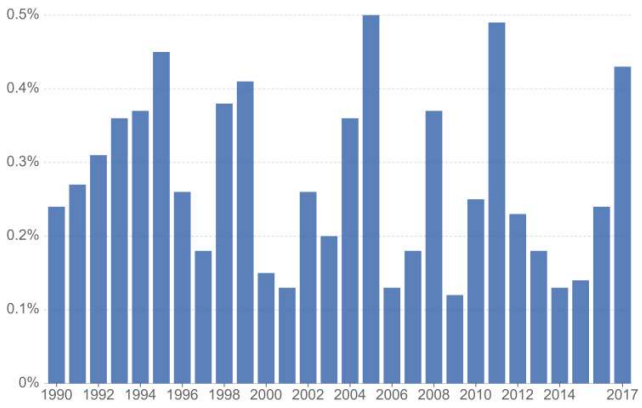


Fig.2.19: Global Disaster Losses as a Share of GDP, 1990 to 2017
Source: Pielke, R. (2018).

To Do Activities
Which disaster causes higher loss of life globally and list possible reasons
Role of Early warning system in reducing the adverse impacts of disasters
Loss of life is coming down due to natural disasters but, economic loss is increasing. Please explain

2.4 Emerging Risks of Disasters

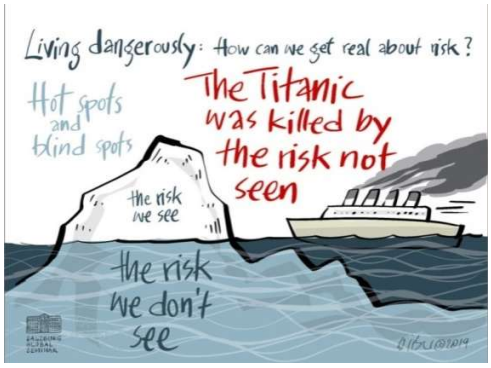


Fig 2.20: Unknown Risks
(Source: Illustration by Wolfgang Irber),

The previous section indicates that the number of disasters are more now compared to previous decades, but with reduced death rate. On the other hand, more population is getting affected and suffering from higher economic losses. This shift can be attributed to four categories of driving forces, viz., demographic, environmental, technological and socioeconomic. These drives have changed the way disasters and accidents spread and generate reactions, and or amplified the vulnerability of vital systems. For instance, flood-plain areas have historically attracted human habitation and thus floods were usual, but as settlements were spread away from flood plains, droughts came to exist.

At the ecosystem level, phenomena like El Niño/La Niña, climate change and the potential for rising sea levels, are affecting the patterns and intensity of hydro-meteorological hazards. Similarly, the same four drivers are also expected to modify the familiar hazards or create new ones, change the way they spread and generate reactions, or amplify the vulnerability of vital systems. Under the influence of these four known drivers and numerousunknown drivers, there is a high likelihood that many conventional risks may take on new forms, and pose new major hazards. Such risks are emerging, but there is extreme

uncertainty about their characteristics and their potential for extensive and perhaps irreversible harm. Cumulatively, may increase the probability of severe damage in a single catastrophic event (natural or man-made), or a complex chain of events appears to be a possibility. This section provides a brief overview of various drivers and possible mitigation measures for emerging risks.

2.4.1 Drivers for Emerging Risks Hazards have a wide spectrum of potential damages. On the extreme side,hazards couldthreaten the stability of macroeconomic conditions (such as inflation, unsustainable public finances) or political stability. On the other end of the spectrum, some hazards present threats to health and human life, property, infrastructures and the environment. The threat to humans is directly proportional to the vulnerable population. As the World population is projected to increase to 9 billion by 2050, is bound to increase strain on resources and systems that are already insufficient in many countries. In near future, at least half of this population, if not more, will be in urban centres and thus increasing the number of cities with more than 1 million population and also the high human density (Table 2.5). Such high-density urban centres could be highly vulnerable, particularly where urban planning is inadequate to the disasters.

Table 2.5: Projected Global Population

Total population	2010	2020	2030	2040
World	6,900	7,700	8,300	8,900
Less developed	5,700	6,400	7,000	7,600
Africa	1,000	1,300	1,600	1,900
Asia	4,200	4,600	4,900	5,100
Urban population				
World	3,600	4,300	5,000	5,600
Less developed	2,600	3,300	3,900	4,500
Africa	400	550	740	980
Asia	1,800	2,300	2,700	3,000
Population 65+				
World	520	720	980	1,300
Less developed	330	480	690	950
Africa	36	50	71	98
Asia	280	400	570	770

Source: United Nations Department of Economic and Social Affairs (2011, 2012)

On The Environment: Potential adverse impacts of global climate change have been adequately documented, albeit with little uncertainty in downscaling. However, it is beyond any doubt that the global climate change is providing positive feedback to the disasters both in incidence and intensity. In addition to the disastrous events, several ecosystem components are also registering the deterioration. Quality degradation beyond a level may trigger other disasters, for instance, water resources. Deterioration of water quality is bound to pave way for several health-related epidemics. Similarly, loss of biological diversity would alter the landscape of natural hazards in the long term. High level of Biological Diversity expands the number of potential interactions inside a system and therefore offers, on average, higher stability and resilience. Thus, the degree of inherent level of biological diversity, to a certain extent, determines the ability of ecosystems to resist and to adapt when a disturbance occurs. The loss of biodiversity, diminishes our ability to respond to the future challenges posed by natural hazards.

Technology: Changing technology is generally associated with an increase in efficiency or lower

consumption of resources for a unit of a given output. For instance, increasing mileage per litre of fuel. It was the technological development that enabled to shift from two-stroke to four-stroke engines and thus achieve higher millage. Similarly, technology can help increase the capacity to cope with disasters, help in mitigation measures. On the other hand, technology can also create new risks or perils, particularly due to three aspects, viz., a) connectedness, b) the speed and c) persuasiveness of technological change (OECD 1998b).

- **Connectedness** is the distinctive feature of modern technology and it made individuals and organisations connected irrespective of distance. This angle as both positive and negative aspects. It has enabled to ensure that relief reaches the victims more efficiently, due to the satellite and wireless communication system. On the contrary, the connectedness has provided a channel through with the disasters can multiply.
- **The Speed**: Technology has enabled a great gain in the speed at which the people can move one place to other and along with them, carry the pandemic as well in great speed to new places. For instance, epidemics spread more rapidly, like Spanish Plague or COVID Corona 19 virus.
- **Persuasiveness**: Breakneck speed of the technology can be seen in the spread of computer malware. In a very short span of the time, it has been observed that computer virus spread across the continent and can disable systems across the world.
- **Socio-economic structures**: With the increasing level of globalization, the role of the private sector in managing the economy has been increasing over several decades, through privatisation, deregulation and regulatory reforms. Policies are increasingly influenced by trade interests and risk management can be impaired by conflicts of interest among the various actors. In some sectors, globalisation, competition and technological change encourage larger scales and higher degrees of economic concentration. This can increase vulnerability to shocks if a vital component is damaged and no alternative is readily available.

Risk Assessment: Current practices of assessing the natural disasters is a combination of four approaches, viz., a) based on a combination of statistical analysis and modelling, b) assessment of risks related to hazardous substances, c) the specific role of dose-response relationships; probabilistic safety assessment of complex engineered systems; and d) consequence assessment, based on methods of cost-benefit analysis. For instance, flood incidences.

Risk prevention Measures to prevent risk can be two types, Ex ante (taken before emergency situation, for instance, construction of dykes to control floods etc) or Ex post (evacuation measures after the flood). Both measures aim to reduce risk. These measures again can be grouped into two categories, one that specifically aimed at reducing a specific hazard, called Protective Strategies. The other group aim to reduce the vulnerability of the particular system and termed as Framework Conditions as they deal with risk culture of a society, such as economic incentives, compensation, or any such measure that influences attitude towards risk.

Protective Strategies Limitations do restrict the capacity of a society to the adoption of suitable protective strategies again a risk, and they may vary from the societies' capacity to bring the necessary resources for risk monitoring and preventive countermeasures to limitations in the form of technical and await the requisite innovations, or even the institutional obstacles to achieve an effective transition from vulnerable society to nationally driven preventive concepts.

To Do Activities
Explain Na-tech disasters What are emergent disasters in Indian conditions Discuss the shift in disaster management from the declaration of International Decade of Natural Disasters

2.5 Climate Change and Urban Disaster

About 55 per cent of the world's population – 4.2 billion inhabitants – live in cities, and expected to increaseand by 2050, nearly 7 of 10 people in the world will live in cities and would become centres of economic activity. More than 80 per cent of global Gross Domestic Product (GDP) generated from urban centres, if managed properly, urban centres can help in increasing productivity, allowing innovation and new ideas to emerge. At the same time, being focused on third-order economic activities, cities/ urban centres may help in reducing the vulnerability of economic activities to vagaries of the environment to some extent. However, it is the speed at which these urban centres registering, raises the concern. Inadequate planning of urban centers make them vulnerable to disasters and several cities have started expressing major concerns about disasters like heatwave, flash floods, storm surge and sea-level change in coastal belt., along with other issues like reductions in freshwater availability etc. Climate change is expected to unleash adverse changes in the speed and scale of disasters and this section presents a brief about them.

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2.5.1 Urban Centers It is difficult to define the geographical limits of an urban place/ city but is a matter of some debate. So far, no standardized international criteria exist for determining the boundaries of a city and often multiple boundary definitions are available for any given city. One type of definition sometimes referred to as the "city proper", describes a city according to an administrative boundary. A second approach termed the "urban agglomeration", considers the extent of the contiguous urban area, or built-up area, to delineate the city's boundaries. A third concept of the city, the "metropolitan area" defines its boundaries according to the degree of economic and social interconnectedness of nearby areas, identified by interlinked commerce or commuting patterns. .

The choice of how to define a city's boundaries is consequential for assessing the size of its population. In Toronto, Canada, for example, approximately 2.6 million people resided within the "city proper" according to the 2011 census, but the population of the surrounding "urban agglomeration" was almost twice as large, at 5.1 million, and the population of the "metropolitan area" was larger still, at 5.6 million.* Furthermore, rates of population growth differed across the three definitions. Between the 2006 and 2011 censuses, the population within Toronto's "city proper" grew at an average annual rate of 0.9 per cent, compared to 1.5 per cent for the "urban agglomeration" and 1.8 per cent for the "metropolitan area".

Table 2.6: Definition of Urban Area

Country	Definition
China	According to the regulation on the classification of urban/rural residence for statistical purposes.
India – State Government	Governor of the state declares by public notification an area as "urban" based on certain parameters, such as the population of the area, the density of the population therein, the revenue generated for local administration, the percentage of employment in non-agricultural activities, the economic importance or such other factors.
India – Census	(a) All administrative units that have been defined by statute (i.e., settlements declared based on state government definition). (b) Administrative units satisfying the following three criteria: (i) A minimum population of 5,000 persons; (ii) 75 per cent and above of the male main working population is engaged in non–agricultural pursuits; and (iii) A density of population of at least 400 persons per sq. km. (1,000 per sq. mile).
USA	Agglomerations of 2,500 or more inhabitants, generally having population densities of 1,000 persons per square mile or more.
Brazil	The area inside the urban perimeter of a city or town, defined by municipal law.
Indonesia	Area which satisfies certain criteria in terms of population density, percentage of agricultural households, access to urban facilities, the existence of additional facilities, and percentage of the built-up area not for housing.
Japan	City (shi) having 50,000 or more inhabitants with 60 per cent or more of the houses located in the main built-up areas and 60 per cent or more of the population (including their dependents) engaged in manufacturing, trade or other urban types of business.
Russia	Cities and urban-type localities, officially designated as such, usually according to the criteria of a number of inhabitants and predominance of agricultural, or number of non-agricultural workers and their families.

Source: United Nations, 2015.[2]

2.5.2 Typical Profile of an Urban Center Some of the typical characteristics of urban centers, which are the driving forces of the growth of these urban centers, make them more vulnerable to the disasters (Allan Lavell et al 2003), viz.,

- Concentrated populations due to concentrated livelihood options/income-earning opportunities for non-agricultural activities (which is what underpins virtually all urban centres);
- Land markets are uncoupled with its agricultural potential, with a result of most or all low-income groups out of "official" land-for-housing markets (deviating from Master Plan of the City, and at times construction in areas that were supposed to serve as a buffer to reduce the intensity of disasters, for instance, floods etc).
- A high density of population in the areas, deviating from Master Plan, without adequate attention to the services like health, sanitation, solid waste management, make those areas more vulnerable.
- Very high level of impermeable surfaces and concentrations of buildings disrupt the natural settings, for instance, disruption of drainage channels and accelerate runoff; consequent urban flash floods, high concentration of construction, increasing the effect of Urban Heat Island etc.

Thus, the urban development in most of the developing economics results in the large risk and also

permits the risk accumulation in everyday life to such an extent that most of the day to day non-disaster events came to be considered as New-Normal life in urban centres. For instance, loss of life minimum of ten people a day in most of the metropolitan cities in India do not attract attention any more (Lavell, Allan (2001).

Table 2.7: Comparing Disasters, "Small Disasters" and Everyday Risk in Urban Centers

Nature of event	Disasters	Small disasters	Everyday risks
Frequency	Generally infrequent	Frequent (often seasonal)	Every day
Scale	Large or potential to be large:10+ killed, 100+seriously injured	3–9 persons killed, 10+ injured	1–2 persons killed, 1–9 injured
Impact on all premature death and serious injury/ illness	Can be catastrophic for specific places & times but low overall	Probably significant and under-estimated contribution	Main cause of premature death and serious injury

Adopted from: Bull-Kamanga et al 2002)

Profile of Urban Centers in India According to the Census (2011), top ten cities of in the country produce about 15 per cent of GDP and host about eight per cent of the total population while occupying only 0.1 per cent of total area. Similarly, the 53 cities that are home to a million-plus population contribute two-thirds of the national economy with about 13 per cent of the population but occupy only 0.1 per cent of the total land area of the country. In the same line, top one hundred cities of the country host about sixteen per cent of Indian population and generate about 43 per cent GOP but occupy only 0.26 per cent of the total landmass of the country (Table 2.8) This profile helps understand various issues that plague the urban centres and their vulnerability to disasters (Revi et al., 2011),

Table 2.8: Number of Towns and Urban Population in India, 2011

Parameter	Statutory Towns (based on state government definition)	Census Towns (based on census office definition)	Total Towns (based on state government and census office definition)
Number of towns	4,041	3,892	7,933
Population (in million)	323	54	377
Share of urban population in total population (%)	26.69	4.46	31.15

Source: Census of India, 2011

2.5.3 Vulnerability of Urban Centers to Climate Change The scale and extent of risk to any particular city depend both on the intensity of disaster and also influenced by the state of infrastructure of that city and its preparedness to face the disasters. Urban centres are vulnerable to several disasters depending on their geographical location and some of them are as follows;

Floods Majority of the urban areas are vulnerable to the flooding whenever rainfall occurs, due to buildings, roads, infrastructure and other paved areas prevent the ground infiltration and hence, entire precipitation turns into a runoff. Coupled with this runoff is encroachment or destruction of the natural drainage system, and choking of the sewerage system results in flooding of low-lying parts of the urban centres. Well planned urban centres rainfall does not present this problem as good provision for storm

and surface drainage is built in. But there, a few urban centres in the country that completely planned and maintained as well. Climate change projections by IPCC Working groups and also by the Ministry of Environment, Forests and Climate Change indicate an increase in short but intense rainfall incidents which are likely to increase the risk of floods in urban centres.

Storms, Sea-Level Rise And Coastal Urban Populations A study examining the number and proportion of urban dwellers (and total populations) living in the low-elevation coastal zone (i.e. less than 10 metres above sea level) found that two per cent of the world's land area comes under low elevation zone but it contains ten per cent of its total population (i.e. over 600 million people) and 13 per cent of its urban population (around 360 million people). Globally, about two-thirds of the world's cities fall in this zone (McGranahan et al 2007). On the other hand, The IPCC states: *"coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea-level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas66 (Adger et al 2007).* Cities play an increasingly important role in tackling climate change because their exposure to climate and disaster risk increases as they grow. Almost half a billion urban residents live in coastal areas, increasing their vulnerability to storm surges and sea-level rise. In the 136 biggest coastal cities, there are 100 million people – or 20% of their population – and $4.7 trillion in assets exposed to coastal floods. Around 90% of urban expansion in developing countries is near hazard-prone areas and built through informal and unplanned settlements.

Higher Temperatures and Heatwaves *Urban Heat Island effect due to* diurnal cycles of absorption and later re-radiation of solar energy and (to a much lesser extent) heat generation from built/paved physical structures is occurring in all cities and can affect the health, labour productivity and leisure activities of the urban population. Urban heat lslands have economic impacts as well in terms of the additional cost of climate-control within buildings, and environmental effects, such as the formation of smog in cities and the degradation of green spaces – and increased greenhouse gases for cooling purposes. (https://www.worldbank.org/en/topic/urbandevelopment/overview)

Climate change has the potential to disrupt the normal functioning of the ecosystem services. Disruptions to the ecosystem services may hamper the normal functioning of the city. For instance, if temperature increases by a few degrees, it will increase the evapotranspiration from surface bodies and may lead to the water shortages in the city. Several other such linkages are given in the Table.

Table 2.9: Sectorial Impacts of Disasters

Sectors	Probable impacts of climate change and disasters
Water Supply.	• Variability inflow of water in perennial and non-perennial rivers will affect water availability. • Variability in rainfall will affect groundwater recharge. • Reduction in water levels in tanks and dams will be seen due to the rise in temperature and variability of precipitation. • Scarcity of water will rise over time and geographically. • Water supply systems such as borewells, pumping stations, water treatment plants, will get affected due to floods • Springs and rivers will be more seasonal in nature due to variability of rainfall and rise in extreme rainfall events • The groundwater table will fall rapidly in over-exploited areas, as recharge of aquifers will reduce due to change in rainfall patterns (more extreme rainfall events leading to high runoff)

Sewerage	• Infiltration of floodwaters into sewers – creating pollution impacting health • Pollution of water downstream. • Due to high temperature & reduced water supply reduced flow may choke sewers and early decomposition may take place resulting in deposits in the network. • Open sewers may overflow due to heavy rains and the threat of epidemic may increase
Sanitation	• Pits would get inundated from below due to flooding situations, polluting groundwater and soil. • Open defecation would spread faecal matter during flooding causing serious health problems. • Silt load carried with floodwater would settle in septic tanks and sometimes there would be backflow of sewage. This would indirectly contribute to water borne and vector-borne diseases in flooded localities. oral DRR

(Source: David Satterthwaite 2015)

Mitigation Pathways *In Second Assessment Report on Climate Change and Cities* (ARC3.2), based on the observation of climate trends and projections of 100 cities around the world, it was concluded that human activities are changing the Earth's climate in ways that increase the risk to cities. To make cities more resilient to climate-related disasters and managing long-term climate risks in ways that protect people and encourage prosperity, five pathways were suggested for adoption with suitable amendments (Rosenzweig 2015).

- Pathway 1: Actions that reduce greenhouse gas emissions while increasing resilience are win-win. Integrating mitigation and adaptation deserves high priority in urban planning, urban design, and urban architecture.
- Pathway 2: Disaster risk reduction and climate change adaptation are the cornerstones of resilient cities.
- Pathway 3: Risk assessments and climate action plans co-generated with the full range of stakeholders and scientists are most effective.
- Pathway 4: Needs of the most disadvantaged and vulnerable citizens should be addressed in climate change planning and action.
- Pathway 5: Advancing city creditworthiness, developing robust city institutions, and participating in city networks enable climate action.

To Do Activities
Describe the disasters that more likely to happen in urban centers
Explain the Climate Change and its potential impact on urban centers
What factors make urban centers as sitting ducks to disasters

Summary of the Chapter

On the basis of their nature, disasters are categorized into geological, Hydro-meteorological, Biological, Environmental and Technological hazards. This chapter provides an brief introduction to some of these disasters about their formation, and possible means of reducing their adverse impacts. In view of increasing incidence of disasters, this chapter also present the global picture about mortality and economic losses due to the disasters. On the other hand, with increasing understanding about disasters, there knowledge about the new and emergent disasters are also increasing. This chapter throws light on them as well. Finally, the chapter presents a birds view on how the climate change would be interfering with urban life in the form of disasters.

Model Questions

- List the natural disaster phenomena likely to occur in the Indian subcontinent. Describe the regional and seasonal profile of any two disasters
- Prepare a list of natural disasters, which are affecting your area **and** explain their impacts.
- Describe how a drought develops from the stage of meteorological drought to agriculture drought.

Reading Materials

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Chapter 3: Disaster Management Cycle

Introduction

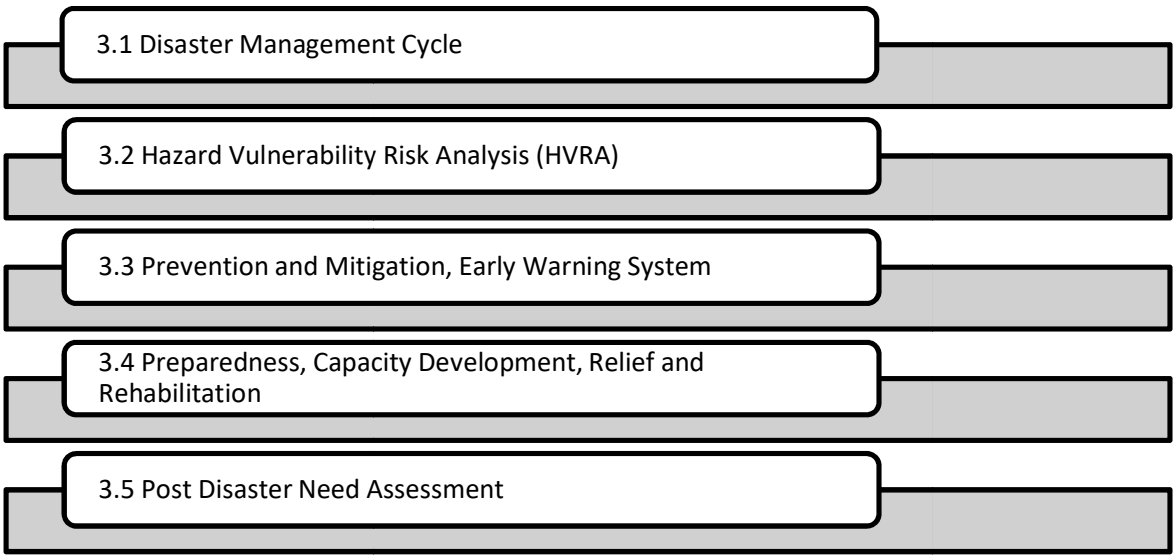
Natural disasters such as droughts, floods, earthquakes, tsunamis, landslides do occur in most parts of the world. Economic losses due to these disasters were estimated to reach an average of US$ 250 billion to US$ 300 billion each year. It was also estimated that the life and economic loss associated with extensive risks (minor but recurrent disaster risks) in 85 low and middle-income countries and territories were equivalent to a total of US$ 94 billion. Taking the increasing population and investment, projected annual losses due to natural disasters were at US$ 314 billion in the built environment alone (GAR 2015). To add to the woes, global climate change projections indicate that both frequency and intensity of these natural disasters are likely to increase and so is vulnerability and consequent damage shooting up several folds (IPCC 2014). Though the disasters were common, its management has drawn due attention only after United Nations has declared the 1990s as International Decade of Disaster Reduction (IDDR). Since then, the strategies have shifted from reactive to proactive and aspects like hazards, exposure, vulnerability have become integral in accordance with global frameworks like Hyogoand Sendai Frameworks. This chapter provides a detailed explanation to various components of disaster management.

Objectives

Objective of this chapter is to provide

- a detailed account of Disaster Management Cycle
- Hazard, Vulnerability, Risk Assessment HVRA
- Significance of measures during pre-disaster phase
- Role of state agencies on preparedness and
- Early warning systems (EWS).

Structure



3.1 Disaster Management Cycle

India is prone to disasters of both geophysical and Hydro-meteorological hazards, resulting in severe economic losses in addition to the loss of life regularly. To safeguard itself from disasters, the Indian government has evolved several policy instruments, legislative enactments to help institutionalisation of the disaster management (DM), by means of preventing and mitigating the adverse impacts of disasters. We can

identify three different phases in the evolution of DM cycle, viz., Phase I: Till 1990, Phase II – From 1995 to 2005 and Phase III from 2015 onwards.

Phase I- Till 1990: During this period, there was no specific approach towards disaster management and the practices followed by the colonial government were only followed. A series of disasters such as famines of 1900, 1905, 1907, 1943, and the Bihar-Nepal earthquake of 1937 have led to the evolution of relief based approach by the colonial government. In the event of a disaster, during the post-disaster phase, a Relief Department under a Relief Commissioner in each province was set up, with overall control by Central Relief Commissioner. Relief Commissioners were to ensure the functioning of 'Food for Work' programmes, while the role of Central Relief Commissioner was limited to dispatch of material and resources to the affected areas (Fig 1).

During post-independence, the same policy of relief was continued. However, through Five Year Plans, aspects like and floods were given attention under "Irrigation, Command Area Development and Flood Control". For instance, construction of multipurpose river projects was undertaken to control floods on one hand and on the other hand to provide irrigation to large tracts of land, but the DM remained activity-based, functioning under the Relief Departments. The primary responsibility of managing the disasters remained with respective state government while the central government role remained largely as supportive in terms of physical and financial resources like transport, warnings and interstate movement offoodgrains. The central Department of Agriculture & Cooperation (DAG) was the nodal Department and an Additional Secretary in the DAC is designated as the Central Relief Commissioner (CRC). The nodal unit was to set the policy climate and efforts were made to share lessons from previous disasters with State governments. CRC serves as the focal pointfor interaction with the State Governments, Departments and agencies of the Union Government and for the implementation of Union Government decisions.

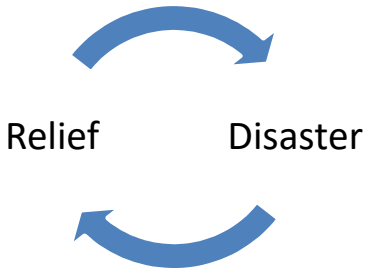


Fig 3.1: Disaster Management Cycle during Colonial Government

Phase II – From 1995 to 2005: During this phase, there have been significant international developments in the field of disaster management initiated by United Nations Organization, such as the declaration of 1990s as International Decade of Disaster Reduction, with a bearing on domestic disaster management policy and a brief description follows;

3.1.1. International Developments in Disaster Management

A. International Decade for Natural Disaster Reduction (IDNDR) 1990 – 2000: Based on the report of the International Ad Hoc Group of Experts on IDNDR, United Nations General Assembly (UNGA) has adopted a resolution to call for a decade of focussed approach for disaster risk reduction. It has the objective of reducing the risks of disasters through concerted international action, for instance, loss of life, damage to property (including earthquakes, tropical cyclones and other storms, tsunamis, floods, landslides, volcanic activity,

wildfires, locust and similar infestations, drought and desertification, and other calamities of natural origin). Member countries were called upon by UNGA to assume the primary responsibility to formulate national disaster mitigation programmes and other such policies that could reduce the consequences of natural disasters. The Framework adopted by UNGA has stated several explicit goals to accomplish during the Decade:

- build national capabilities to mitigate the effects of natural disasters;
- develop guidelines and strategies for applying existing knowledge;
- foster research to close gaps in knowledge; disseminate information;
- develop measures to apply technical assistance and technology transfer, demonstration projects, and education and training; and
- all countries to
  - conduct a national hazard risk assessment;
  - incorporate a sustained disaster mitigation strategy into the national economic development plan; and
  - ensure improved access to effective early warning practices at all levels of responsibility.

B. United Nations Conference on Environment & Development, Brazil, 1992 AGENDA 21 has also emphasized that sustainable economic growth and development cannot be achieved without taking measures to reduce losses from natural disasters. Principle 18 of the Rio Declaration on Environment and Development has stressed the need for the international community to assist States afflicted by natural disasters and other emergencies.

C. International Strategy for Disaster Reduction (ISDR): During the midterm evaluation of IDNDR at World Conference on Natural Disaster Reduction in Yokohama, 1994, the concept of disaster reduction was enlarged to cover natural and other disaster situations and at the end of IDNDR, 1999, it has led to the creation of the International Strategy for Disaster Reduction (UNISDR) in December 1999, as the secretariat for the International Strategy for Disaster Reduction (ISDR) system and was adopted by the United Nations Member States in 2000.

D. Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation 1994: The first-ever document providing guidelines at the international level for preparation for and prevention and mitigation of disaster impacts. The Strategy has outlined principles and specific recommendations for action at the community and national levels, at the regional and sub-regional levels, and at the international and bilateral levels of involvement. It is focused on improving coping mechanisms in order to better cope with and recover from disasters' impacts. To facilitate an easy and fast recovery process, it recommends the knowledge and experience in managing emergencies that exist at the local level among at-risk communities.

E. Hyogo Framework for Action (HFA) 2005- 2015: The Second World Conference for Disaster Reduction was held, Hyogo, Japan in 2005, in the aftermath of the 2004 tsunami in the Indian Ocean, affecting millions of people and has helped to raise awareness about disasters and their risks, along with serious impacts. During the evaluation of Yokohama Strategy, specific gaps and challenges are identified in the following five main areas:

- Governance: organizational, legal and policy frameworks;
- Risk identification, assessment, monitoring and early warning;
- Knowledge management and education;
- Reducing underlying risk factors;
- Preparedness for effective response and recovery.

These are identified as the key areas for developing a relevant framework for action for the decade of 2005–2015. The final outcome of the conference is the Hyogo Framework for Action 2005–2015 (HFA). The HFA was a 10-year action plan, effective from 2005 to 2015 and is probably the most significant international

document popularizing the notion of Disaster Risk Reduction (DRR). HFA reflects a stronger focus on risk preparedness and prevention, as opposed to the emphasis on response and recovery during the previous decades. HFA outlines five priorities for action, and offers guiding principles and practical means for achieving disaster resilience, and also suggests various activities at the national level.

Fig 3.2: Major DRR Areas under HFA

Table 3.1: Action Plan under HFA

Priorities	Key Activities
Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.	National institutional and legislative frameworks Resource Community Participation
Identify, assess and monitor disaster risks and enhance early warning.	National and Local Risk Assessment Early Warning System Capacity Building Regional and Emerging Risks
Use knowledge, innovation and education to build a culture of safety and resilience at all levels.	Information management and exchange Education and Training Research Public Awareness
Reduce the underlying risk factors, and	Environmental and natural resource management Social and economic development practices Land-use planning and other technical measures
Strengthen disaster preparedness for effective response at all levels	Strengthen policy, technical and institutional capacities in regional, nationaland local disaster management, including those related to technology, training, and humanand material resources.

F. The Sendai Framework for Disaster Risk Reduction 2015–2030 (SFDRR): At end of HFA, commitments to support DRR were renewed in the form of SFDRR, finalized in Sendai, Japan in 2015.

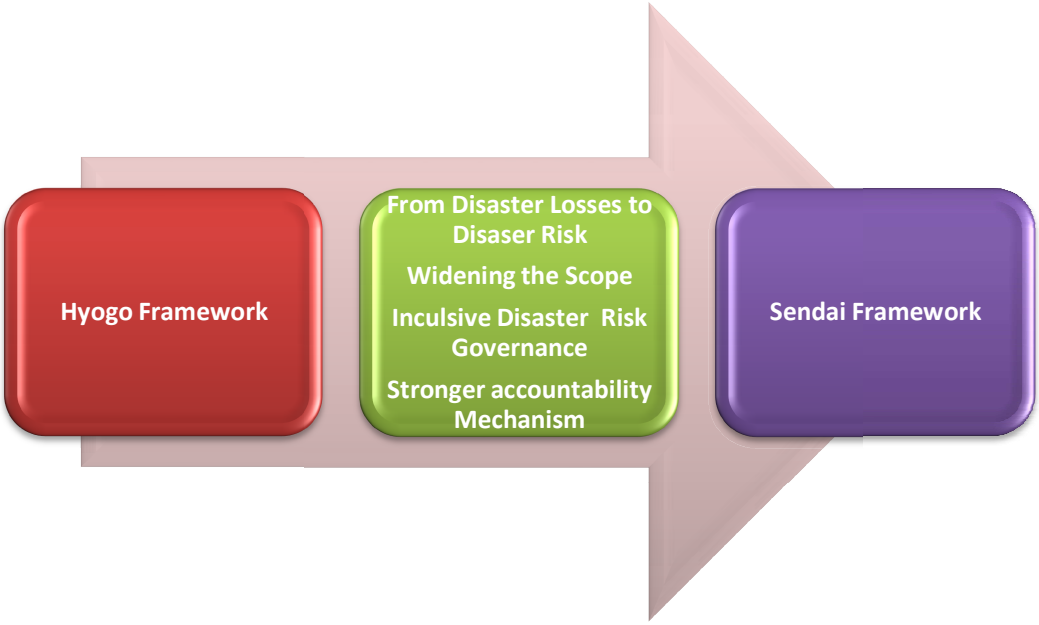


Fig 3.3: From Hyogo to Sendai Framework (Source: UNISDR)

Bbased on the learning from the HFA, the Sendai Framework for Disaster Risk Reduction (SFDRR) prioritises, , on understanding disaster risk and strengthening governance at global and regional levels. It also recognises that this must involve the application of risk information in all its dimensions. It comprises a voluntary set of targets and priorities to foster increased resilience to present and future hazards and to prevent setbacks to development as the result of small and large disasters. Priorities of SFDRR are as follows;

- Priority 1 Understanding disaster risk
- Priority 2 Strengthening governance and institutions to manage disaster risk
- Priority 3 Investing in disaster risk reduction for resilience
- Priority 4 Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

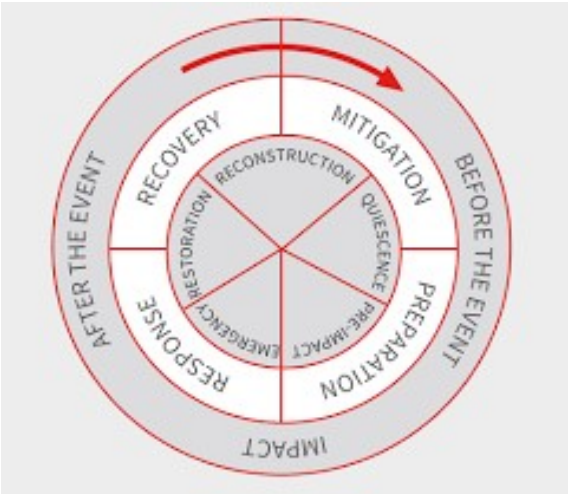


Fig 3.4: Mainstreaming DRR
(Source: UNDRR 2015)

3.1.1.1 National Developments in Disaster Management

Disaster management in India was reactive in nature and has evolved from an activity-based reactive setup. Due to the increasing incidences, it turned to a proactive institutionalized structure; from single faculty domain to a multi-stakeholder setup; and from a relief-based approach to a 'multi-dimensional pro-active holistic approach for reducing risk' with the increase in the understanding of disasters. Thus, DM in India is a product of both international developments and also the national experiences and it is manifested clearly in Financial Commission Reports (Table 3.2).

Fig 3.5:Disaster Management Cycle in India (source: NDMA)

Table 3.2: Disaster Management Concerns under various Financial Commissions

FC	Year	Main Focus Area	Operational duration
I	1951	a. distribution of net proceeds of taxes between the Union and the States b. the principles which should govern the grants-in-aid of the revenues of the States out of the Consolidated Fund of India	1952–57
II	1956		1957–62
III	1960		1962–66
IV	1964		1966–69
V	1968		1969–74
VI	1972		1974–79
VII	1977		1979–84
VIII	1983	review the policy and arrangements in regard to the financing of relief expenditure by the States affected by natural calamities and suggest such modifications as it considers appropriate, in the existing arrangements, having regard, among other considerations, to the need for avoidance of wasteful expenditure."	1984–89
IX	1987	review the policy and arrangements in regard to the financing of relief expenditure by the States affected by natural calamities and suggest such modifications as it considers appropriate, in the existing	1989–95

		arrangements, having regard, among other considerations, to the need for avoidance of wasteful expenditure. The Commission may examine, inter alia, the feasibility of establishing a national insurance fund to which the State Governments may contribute a percentage of their revenue receipts.	
X	1992	review the present scheme of Calamity Relief Fund and may make appropriate recommendations thereon. The Commission may make an assessment of the debt position of the State as on 31st March 1994, and suggest such corrective measures as are deemed necessary also keeping in view the financial requirements of the Centre."	1995–2000
XI	1998	review the present scheme of Calamity Relief Fund and may make appropriate recommendations thereon."	2000–2005
XII	2002	review the present arrangements as regards the financing of Disaster Management with reference to the National Calamity Contingency Fund and the Calamity Relief Fund and make appropriate recommendations thereon.	2005–2010
XIII	2007	review the present arrangements as regards the financing of Disaster Management with reference to the National Calamity Contingency Fund and the Calamity Relief Fund and the funds envisaged in the Disaster Management Act, 2005(53 of 2005), and make appropriate recommendations thereon.	2010–2015
XIV	2013	need to balance management of ecology, environment and climate change consistent with sustainable economic development	2015–2020
VX	2017	..the Commission may consider proposing measurable performance-based incentives for States, at the appropriate level of government, in following areas: Achievements in implementation of flagship schemes of Government of India, disaster-resilient infrastructure, sustainable development goals, and quality of expenditure; Achievements in implementation of flagship schemes of Government of India, disaster-resilient infrastructure, sustainable development goals, and quality of expenditure; The Commission may review the present arrangements on financing Disaster Management initiatives, with reference to the funds constituted under the Disaster Management Act, 2005, and make appropriate recommendations thereon.	2020–2025

Source: Reports of Different Finance Commissions

To Do Activity

Describe different phases in the evolution of disaster management in India

Mention about the International Frameworks that have influenced the disaster management in India

Present an analysis of different institutions involved in disaster management in India.

3.2 Hazard Vulnerability Risk Analysis (HVRA)

Some of the hazards, such as Earthquakes, cannot be prevented .Adverse impacts due to these hazards are dependent on various factors such as the intensity of disaster, exposure, vulnerability and risk. Hence, any preventive and mitigation measures should be planned based on these factors and evaluation of these factors to any disaster can be termed as Hazard Vulnerability Risk Analysis (HRVA).

3.2.1 Components of HRVA: As can be seen from the table, 3.3, evaluation of three elements, viz., Probability, Impact and Preparedness constitute HVRA.

Table 3.3: Key Componentsof HVRA

Probability	Impact	Preparedness
Risk	Human	Plans
Historical data	Property	Resources
Predictive data	Business	Partnerships

3.2.1.1 Probability Depending on its geographical situation, the probability of an incidence can be estimated. For instance, a settlement in the eastern coast of India has a higher probability of cyclone and storm surge than a similar settlement on the western coast of India. Similarly, a hamlet situated in a floodplain of a river has a higher probability of floods and consequent damages than a village that is located away from floodplains. We can estimate the probability of occurrence of disaster based on a) general risk, b) historical data, and c) based on Predictive data (Table 3.4).

General Risk: Factors like exposure, proximity or susceptibility to hazard elevate the probability of disasters several folds. For instance, hamlets along the national highways are in close proximate with dense vehicular traffic and thus their exposure to fatal incidents are much higher. Similarly, it is common to observe the settlements on river bed downstream of barrages in an urban center, and they are exposed to the threat of flash floods during monsoon months as excessive floods waters may be released to downstream from reservoirs.

Table3.4: Factors influencing the Probability of Disaster

Disasters	Exposure	Proximity	Susceptibility
	(1 low, 5 high)	(1 low, 5 high)	(1 low, 5 high)
Flood plains, seismic faults or dams	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Companies that produce, store, use or transport hazardous materials	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Nuclear power plants	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Major transportation routes and airports	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Proximity to other larger facilities	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Proximity to potential targets of terrorism	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

(Source

Historical Data: Examining the previous recorded data of incidences of disasters could provide valuable information about the probability of occurrence of the disasters. Records of incidence of various disasters and consequent loss of life and economic losses are generally maintained by the revenue authorities. By examining the recorded data of disasters, one can analyse the seasonality of disasters in a region and can assess the probability of disastrous incidence (Table 3.5).

Table 3.5: Seasonality of Disasters in India

Hazards Vs Months	January	February	March	April	May	June	July	August	September	October	November	December	Intensity
Cyclone													V.High to High
Flood													High
Earth Quake													MediuM
Drought													V.High to moderate
Chem.Industrial													High
Heat Wave													V.High to moderate
Fire													Moderate
Epidemics													Medium

(Source : Adopted from Karnataka State Disaster Management Plan 2020)

Predictive Data: with significant advances in technologies such as remote monitoring techniques and development of supercomputing systems have enabled to predict the possibility of events like cyclones, hailstorms etc in a few days advance. With rapid advances in Geographical Information Systems (GIS), several Digital Elevation Models (DGM) were developed which can estimate the possibility of occurrence of floods its extent based on the rainfall data in the catchment area.

3.2.1.2 Impact Every disaster causes disruptions in socio-economic –ecological processes and its extent depends on its intensity on one hand and the vulnerability on the other hand. These impacts can be assessed at three levels, viz., humans, infrastructure,/economic processes, and ecological processes.

Impact on Humans: Some disasters like flash floods result in direct losses such as loss of life, while some disasters may not have direct impacts such as floods, for instance, the earthquake does not cause any damage either to human or livestock life, but it is in the aftermath of the earthquake, the collapse of physical structures or even removal of overlying debris which actually results in injuries or even the loss of life. Similarly, drought, a slow creeping disaster does not cause any direct damage either to life or to property but has a wide variety of consequences, ranging from malnutrition to migration to distress sale of assets etc.

Impact on Infrastructure: With the exception of drought, all other disasters are known to cause damage to infrastructure and extent of damage is proportional to the intensity of the disaster and exposure and vulnerability of the infrastructure. Thus, it is most common to notice that most of the disasters cause severe damage to the basic communication infrastructure such as roads, electricity, communication network etc. Damage to a communication network, such as damage to mobile towers etc cripple communication system and wireless communication system with district administration becomes only means of communication. Similarly, damage to the road network hampers the speed of rescue and relief activities. Another most

important segment of infrastructure is that of damage to critical infrastructure like hospitals, water treatment plants etc. In view of their importance, priority is given to the restoration of critical infrastructure at the earliest possible in post-disastersituations.

Impact on Business Activities: Damage to the infrastructure along with loss of life or injuries tend to result in a collapse of supply/ value chains and might bring an abrupt halt to the business transactions in disaster-affected areas. Such interruptions would push wage earners into difficult times. At times, physical damage to buildings may even cause loss of records, data etc. Details of losses suffered by the agriculture in the state of Karnataka is given in Table 3.6.

Table 3.6: Typical Estimation of Disaster Induced Losses to Agriculture in Karnataka

No.	Name of the Disaster	2016-17		2017-18		2018-19		2019-20	
		Area affected*	Economic Loss*	Area effected	Economic Loss	Area effected	Economic Loss	Area effected	Economic Loss
1	Floods	3.73	1737.88	-	-	0.23	313.52	8.02	14152.75
2	Drought	23.77	1637.37	-	-	46.77	26514.32	6.56	5234.82
3	Hail storm	-	-	-	-	-	-	-	-
4	Pest attacks	-	-	-	-	-	-	-	-
5	Wind storms	-	-	-	-	-	-	-	-
6	Land slides	-	-	-	-	-	-	-	-
7	Heavy Rains	-	-	-	-	-	-	-	-

*area affected= loss of sown area + area affected by disaster-Lakh ha. Economic Loss = As per Cost of Cultivation in RsCrores..

(Source: Complied from Memorandums submitted by Government of Karnataka)

3.2.1.3 Preparedness: Probability helps in guess-estimating the possibility/probability of a disaster taking place and its likely level of intensity. Estimation of its impact based on its probable intensity helps in identifying its potential impacts on various stakeholders and economic activities in a region. But, it is the level of actual preparedness that determines the extent of damage. Higher the level ofpreparation, lower would be the loss of life and economic losses, on the other hand, lower the level of preparedness, higher could the loss of life and to the economy . Hence, to ensure the highest level of preparedness, all vulnerable societies have developed various mechanisms such as adisaster management plans, b) mobilisation of resources, c) Partnerships etc.

3.2.2 Disaster Management Plans: Keeping the vulnerability of our country to the disasters, the disaster management regime has evolved into three-tier approaches, viz. National, State and district level.

- **National Disaster Management Plan**: Monsoons play a very important role in the Indian economy and more than 75 per cent of rainfall occurs within a two month period. There could wide deviations in amount of rainfall from long term average rainfall and thus some states may receive excess rainfall and subsequent flood situation, while some other states may receive less than long term average

rainfall and drought conditions may prevail. Under such circumstances, national plans come very handy to deal with the circumstances as they lay down Standard Operating Procedures for preventive and mitigation measures.

- **State Disaster Management Plan**: This plan deals with the disaster at the state level, for instance, floods and/or drought in several districts of the state. State Disaster Management Plan is a codification of standard operating procedures to be followed by different departments to deal with disasters. They lay down an elaborate approach for different phases, viz., pre, during and post-disaster phases and are supposed to be updated annually.
- **District Disaster Management Plan**: District is a basic unit of administration in India and National Disaster Management Act 2005 stipulates that every district shall have a disaster management plan. These plans, based on the historical data, have made HVRA and have identified the vulnerable regions and communities in the district. In case of disasters, suitable measures such as evacuation to safe places etc. can be made.

Mobilisation of Resources: Disasters can severely cripple the infrastructure and may put severe limitations in moving essential goods such as medicines from neighbouring districts and hence, stocking essential items like emergency medicines may help in ensuring the quick relief to the affected communities. Partnerships with civil society organizations and community-based organizations can help to ensure efficient management of finite resources and also optimise the rescue and relief activities in post-disasterphase..

To Do Activity
Describe different aspects of HVRA
Describe the seasonlity of disasters in your region
How significant is Preparedness in mitigating the disaster related losses

3.3 Prevention and Mitigation, Early Warning System

3.3.1 Prevention measures are attempts to avoid exposure to the disaster and associated adverse impacts. Preventive measures express intention to avoid exposure to hazards through actions taken in advance based on the HVRA and fall into two categories, viz., measures to prevent the hazard, for instance, construction of dams to prevent the floods, and b) measures to avoid the exposure, , spray of disinfectants to control vector-borne diseases or shifting the villages located in floodplains to areas without exposure to floods. However, in most of the cases, complete insulation from hazards is not possible or practical. Under such circumstances, measures that can reduce the adverse impact of the disaster will be adopted and are termed as mitigation measures. To be effective,the strategy should include multiple strategies, i.e., one hand, to reduce or remove the impact of hazards and on the other hand, to increase the resilience of the community. Disaster Prevention measures include:

- Integrating disaster prevention with national development plans. The culture of disaster prevention needs to be a part of development plans and projects. Measures directed at reducing the occurrence of floods through the construction of embankments etc., promoting earthquake resistant structures, watershed management, rainwater harvesting, alternative cropping patterns etc., to manage situations of drought are efforts towards disaster prevention.
- Formulating appropriate disaster management policies facilitates the proper implementation of preventive measures at all levels by the concerned stakeholdes.
- Making the community aware, educated and their capacities built to manage disasters make them self-reliant and resilient to cope with disasters.
- Involving educational, training institutions, corporate sectors, and non-governmental organisations (NGOs) in eliciting public participation, generating awareness amongst all concerned stakeholders.

- Strengthening of existing infrastructure such as buildings, communication system, water supply, sanitation facilities 'etc.

3.3.3 Mitigation Risks can be categorized into three groups (DFID 2003), viz.,

- Risks arising from factors actually or potentially under control (e.g., poor design, ineffective management systems, poor performance by contractors).
- Risks arising from factors in the wider policy and institutional environment that are only controllable by decision-makers elsewhere (e.g., poor policy environment, institutional weaknesses; lack of political will).
- Risks that are essentially 'uncontrollable' (e.g., natural disasters, political instability, world prices, interest rates).

For the risks that fall are under control group, with due attention and appropriate preventive measures, the risk can be eliminated completely or reduced to a great extent. However, for those risks that are beyond control, preventive measures are of little meaning, for instance, we can not prevent the earthquakes from happening. Similarly, we can not prevent the formation of cyclones or tsunami or even the onset of drought conditions. Under such conditions, measures that would help to reduce the impacts can be undertaken and these measures are collectively called as mitigation measures. For instance, we can not prevent earthquakes but we can reinforce the buildings in earthquake-prone areas to reduce the damages to some extent. These measures are can be termed as a mitigation measure against possible future risks. On the other hand, measures like preparedness, response and recovery are associated with specific events. Better the mitigation measures, the damages tend to be lower and hence, lower would be the required efforts for rescue, relief, assistance, reconstruction in the post-disaster phase. Further, the Yokohama Strategy has underlined that Disaster prevention, mitigation and preparedness are better than disaster response in achieving the goals and objectives of vulnerability reduction, as shown in the table. We can not prevent the incidences of Earthquakes. But, we can take measures that could help to reduce the severity of adverse impacts of earthquakes, for instance, retrofitting to the old and weak structures, adherence to the appropriate building codes during the construction of new building etc. The table 3.7 presents the impact of earthquakes that are similar in magnitude but their impacts vary vastly and the difference in only due to adoption of mitigation measures. During an Earthquake of 8.3 in Hokkaido city of Japan, there was no loss of life at all but an earthquake of 6.9 in Bhuj in Gujarat has caused a loss of life of more than ten thousand, indicating the significance of mitigation measures.

Table 3.7: Influence of Prevention, Mitigation Measures

Country/ Place	Date	Intensity of Quake	Human Lives Lost
USA			
Southern California	28.6.1991	6.2 M	2
Landers California	28.6.1992	7.3 M	3
Oregon	21.9.1993	6.4 M	2
Northridge, California	17-1-1994	6.9 M	60
Wyoming	3-2-1995	6.7 M	1
Central California	22-12-2003	6.8 M	2
JAPAN			
Hokkaido	25-9-2003	8.3 M	0
Kobe	16.1.1995	6.9 M	5530
Kamchatka	12-5-2005	7.3 M	0
Fukuoka	20-3-2005	6.5 M	0
Honshu	16-8-2005	7.2 M	0
INDIA			
Uttarkashii	20.10.1991	6.6 M	2000
Latur	30.9.1993	6.3 M	9475
Jabalpur	22.5.1997	6.0 M	39
Chamoli	29.3.1999	6.8 M	100
Bhuj	26.1.2001	6.9 M	13805

(Source UNDP 2004)

Mitigation efforts are aimed at;

- Help to prevent the hazards to become disasters,
- Increased awareness in the community about the risks and encourage the participation of the community to reduce the risks
- Strengthening the pre-disaster preparedness and prevention measure that help the effected community recover soon from the adverse effects of the disaster

Carter (1991) identifies the following principles as providing a guide to mitigation:

- **Initiation:** This includes introducing disaster mitigation activities within three diverse contexts of reconstruction, new investment and existing environment.
- **Management**: Mitigation measures are complex and interdependent and they involve widespread responsibility, coordination, incentives, the spread of safety measures through diverse activities and integrated with preparedness, relief and reconstruction.
- **Prioritisation**: Where resources are limited, priority should be given to the protection of key social groups, critical services and vital economic sectors.
- **Monitoring and Evaluation**: Mitigation measures need to be continually monitored and evaluated so as to respond to changing patterns of hazards, vulnerability and resources.
- **Institutionalisation**: Mitigation measures should be sustainable and political commitment is vital to the initiation and maintenance of mitigation.

3.3.2.1 Categorisation of Mitigation Measures: Mitigation measures can broadly be grouped into approaches, viz., structural and non-structural

Structural Approaches refers to structural measures resorted to tackling the disaster threats. This applies to

both engineered and non-engineered structures (those Buildings, and infrastructure built with local know-how, not in accordance with prescribed specifications, These are generally constructed as per the convenience of the local community, in a traditional manner. These include houses lying on steep slopes, which can be subject to landslides). The structural measures comprise additional structural components to ensure the safety against perceived vulnerability based on informed advice. For instance, the National Building Organisation (NBO) has developed the National Building Code and published codes for the construction of earthquake-resistant buildings. **Structural Measures for control of Floods** include following measures,

- Embankments/Banks, Flood Walls, Flood Levees: offer a degree of protection against floods of a certain frequency and intensity. Embankments with proper roads also serve as a communication link in the area. However, breaches can result in large-scale flooding in protected areas.

- Dams, Reservoirs and other Water Storages can store floodwaters and release subsequently when the flood has receded. The stored water can also be used subsequently for irrigation, power generation, and meeting industrial and drinking water needs.

- Channel Improvement can be made to carry additional flood discharge by improving its discharge carrying capacity. However, the associated costs make this option a little less preferable. Similarly, the desilting or dredging of watercourses improves the performance.

Diversion of Flood Water Diverting all or a part of the discharge into a natural or artificially constructed reservoir, , lying within the command area or in outside the flood plains is a useful means of controlling flood on one hand and providing water to water-scarce regions.

Non-structural Approaches encompasses - cooperation and networking amongst several stakeholders. Effective mitigation needs strengthening the capacities of communities along with the administrative machinery.

Appropriate **Administrative/Regulatory** Framework to ensure adherence to mitigation measures. This includes planning and zoning, application of building codes, hazard-resistant design and construction,
Public Education, Training and Awareness towards mitigation with appropriate dissemination of information to the vulnerable community people with a view to educating them about potential hazards and ways of reducing them. This activity could engage mock drills, exercises, awareness campaigns, simulation exercises, carrying out the worst scenario analysis etc.
Community Participation in Disaster Mitigation Community participation is the most important component in every mitigation policy as it is the first to respond when disaster strikes. If they are familiar with the local area vulnerabilities, available resources, facilities, demography, disaster mitigation plans could far more effective.

3.3.3 Early Warning Systems (EWS) Early Warning System (EWS) forms as a central point within the entire chain of disaster management events and it can help to reduce losses/ damages to a great extent. Though the nature of EWS may vary depending on the kind of the disaster, it basically aims to communicate about the potential hazard and pre-warn the community about the possible disaster and thus enable the community to undertake most appropriate measures to deal with impending disaster. The term 'Early Warning' is generally used to describe the provision of information on an emerging dangerous hazard that enables advance action to reduce the associated risks and it may address natural (geophysical, biological hazards), complex socio-political emergencies, industrial hazards and personal health risks, etc. In United Nations International Strategy for Disaster Reduction (UNISDR 2004) defines early warning as 'the provision of timely and effective

information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid their risk and also to prepare for effective response' .
EWS play an important role by pre-warning the vulnerable community about impending hazard and enables the community to take appropriate measures to mitigate the adverse effects of disaster. It was internationally acknowledged that, had EWS for Tsunami was in place, devastation by the tsunami in the Indian Ocean in 2004 which took about 220,000 human lives would have been far less, indicating the significance of EWS.

EWS provides a unique opportunity to empower individuals and communities with information that could help them to act in sufficient time and in an appropriate manner to reduce the possibility of personal injury, loss of life and damage to property and the environment when they threatened by hazards. Thus a proper EWS can reduce the negative economic, environmental and social impacts of extreme events through measures to prevent or mitigate their effects (UN 2005).

3.3.3.1 Pre-Requisites of EWS: The primary objective of preparing and delivering EWS to users is to enable the end-users to make better decisions by using weather and climate information. End-User community or stakeholders may vary from government authorities to the public and EWS should be able to cater to the specific needs of each of the stakeholder groups. To generate intended reactions from stakeholders in the wake of a disaster, EWS must be people-centred and integrate four elements, viz., a) risk knowledge; b) technical monitoring and warning service; c) communication and dissemination of warnings; and d) community response capability.

- **Risk Knowledge**: Adequate assessment of vulnerabilities to various disasters and risks is the beginning point for proper disaster management. Based on historical experiences,HVRA can be made and pattern, trend and extent of risk from disasters can be profiled. Such profile helps to prioritize the early warning system to optimize its utility and also to guide preparations for appropriate mitigation or prevention.
- **Monitoring and Warning Service**: Monitoring network for various parameters provides the crucial information which helps in predicting the weather elements. Constant monitoring of possible disaster precursors is necessary to generate accurate warnings on time. Therefore, higher resolution, both of spatial and temporal monitoring network, higher would be the accuracy of prediction. Adopting a monitoring network that collects information about many hazards and also involves various monitoring agencies is most effective and economical as well. Equally, the important aspect is analyzing the monitored data to develop the prediction and depending on the level of expertise, it can be developed in-house or outside assistance can be taken.
- **Communication and Dissemination**: Once the prediction is made, then it is vital to convey the same to end-user or those at risk, in a very clear and understandable message/warnings. For end-user to initiate the appropriate actions, the messages should provide them with clear, useful information. For reaching out to the end-user community, well-established channels of communications should be in place, and these channels must have Regional, national and community level reach.
- **Response Capability**: Once the end-user community receives the Early Warning Message, communities must be in a position to understand their risks and capable of reacting. Sustained efforts to bring awareness can help to take a community to that level. To make a community as prepared one, it requires the participation of formal and informal education sectors, addressing the broader concept of risk and vulnerability

3.3.3.2 EWS in India: India has a tradition of undertaking monitoring and forecasting the weather conditions and advising the concerned stakeholders through meteorological Forecasts, Alerts, Early warnings and advisory communication. Predictions were made in the category of Long-Range Forecast (LRFs). The first operational LRF for seasonal monsoon rainfall was issued on June 4, 1886, and was based on antecedent Himalayan snow cover (Blanford 1884). Indian Meteorology Department (IMD) began its regular weather

services for the benefit of farmers in 1945 "Farmers' Weather Bulletin" through All India Radio in regional languages. In 1971. On the recommendation of the National Commission on Agriculture (NCA), IMD has launched Agro-meteorological Advisory Services (AAS), a tool tailored to suit farmers' need .

To Do Activity
Describe different aspects of HVRA Describe the seasonality of disasters in your region How significant is Preparedness in mitigating the disaster related losses

3.4 Preparedness, Capacity Development, Relief and Rehabilitation

3.4.1 Disaster Preparedness refers to a set of activities/ measures that are taken to prepare for and also to prevent and reduce the impacts of disasters. Thus, preparedness involves prediction of potential disasters and wherever possible to prevent them to the extent possible and measures to mitigate their impacts on vulnerable communities. Thus, preparedness, in general, speaks of a Goal to be achieved in disaster management and is a continuous process involving all the stakeholders rather than a specialised programme or stage that immediately precedes disaster response. Disaster preparedness is a continuous and integrated process resulting from a wide range of activities and resources rather than from a distinct sectoral activity by itself. It requires the contributions of many different areas—ranging from training and logistics, to health care to institutional development. Viewed from this broad perspective, disaster preparedness encompasses the following objectives:

- Increasing the efficiency, effectiveness and impact of disaster emergency response mechanisms at the community, national and Federation level. This includes:
  - the development and regular testing of warning systems and plans for evacuation or other measures to be taken during a disaster alert period to minimise potential loss of life and physical damage
  - the education and training of officials and the population at risk
  - the training of first-aid and emergency response teams
  - the establishment of emergency response policies, standards, organisational arrangements and operational plans to be followed after a disaster
- Strengthening community-based disaster preparedness through ourreach or NSS activities for the community.
- Developing activities that are useful for both addressing everyday risks that communities face and for responding to disaster situations (IFRC 1997).

3.4.1.1Disaster Preparedness Measures

- **Hazard, Risk and Vulnerability Assessments:** It is on the basis of HRVA that the preparedness measures are based and prioritised. Ideally, the HRVA assessment should a) Identify the frequency and the potential severity that the community may be exposed to, b) depending on the vulnerability, categorise the areas on the basis of severity, c) Identify the most vulnerable groups within the exposed community, and main sectors that might be effected such as infrastructure, transport, water etc, and d) assess the current ability of concerned stakeholders to cope with the effects of disaster.
- **Response mechanisms and strategies:** Based on the HRVA, identify the most appropriate strategies to have an effective response mechanism. These strategies should be about to deal effectively with;
  - Evacuation, search and rescue teams
  - Restoration of emergency services like electricity, communication, health etc
  - Distribution of emergency relief materials
  - Damage assessment

- **Preparedness Planning:** During disasters, quick action is required and its effectiveness depends on having made and implemented preparedness plans before the disaster hits. Though, exact dimensions of a disaster are difficult to predict, preparedness requirements can be predicted with reasonable accuracy. The planning process, therefore, requires the identification of possible requirements and preparing such an eventuality.

- **Coordination** is most important element during the crisis. A proper coordination is essential and an effective coordination can save many a lives and significantly reduce the losses. To ensure the proper coordination, Incident Command System was evolved and implemented.

- **Information Management**: Flow of uninterrupted and current information is essential to ensure the proper responses in various phase of disasters, viz., pre, during and post disaster phases. Emergency Operations Centers (EOC) at district headquarters play a very important role to collect the information at district level and pass it on to state and central agencies to plan appropriate measures.

- **EWS:** Till early 80s, death toll in cyclones used to be on higher side, but the mortality rate during cyclonic events has drastically reduced and this is due to the advances made in EWS. EWS helps the vulnerable community to prepare for the disaster and thus reduce the loss of life, though economic losses can not be prevented.

- **Resource mobilization** Disasters are bound to cause significant damages and HVRA can help in identifying the potential damages. Strategies and procedures for mobilising and acquiring emergency funds, supplies and equipment can play a significant role in helping the effected community to return to pre-disaster level sooner.

- **Public education, training and rehearsals/nmockdrills** promote an informed, alert and self-reliant community that can prepare itself and play a part in tandem with government agencies in reducing the disaster related damages.

- **Community-based disaster preparedness (CBDP)** is a process that develops and implements a locally appropriate and locally "owned" strategy for disaster preparedness and risk reduction.

3.4.2 Capacity Building for Disaster Risk Reduction: Capacity is defined as “the combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals’ (UNISDER). Capacity Development is defined as “the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time’ (UNDP). UNISDR defines capacity building as “the process by which people, organizations and society systematically stimulate their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems and institutions”.

Though the language differs with each definition, capacity building largely refers to three main aspects, viz. overall capability to manage its own development process, b) nature of ongoing process of change over the time, c) issues and priorities based on the background and d) context of the stakeholders. From the disaster management perspective, capacity building refers to multi-dimensional approach and relate as much to broader societal challenges. Further, we can identify capacity at three different levels, viz.,

- The Enabling Environment or Creation of Institutions: At this level, the ‘rules of game’ are framed and largely determines how the society operates, flow of actions and interaction between different

stakeholders etc. Creation of National Disaster Management Act and National Disaster Management policy can be said to examples of this level. They have created entire gamut of disaster management in India and have laid the foundation for creation of various institutions and organizations. .

- The Organizational Level of capacity deals with internal policies, systems and strategies, arrangements, procedures and frameworks that allow for effective management of disaster management. For instance, the Emergency Operation Centers are an organization to facilitate timely interventions to mitigate the adverse impacts of disasters and quick disbursal of relief materials, for instance, District Disaster Management Plan enables various departments to reach out to the effected communities.
- The Individual Level Capacity describes the skills and knowledge that are vested in people (individuals, communities, groups, teams/ departments). For instance, Departmental Disaster Management plans comes under this category.

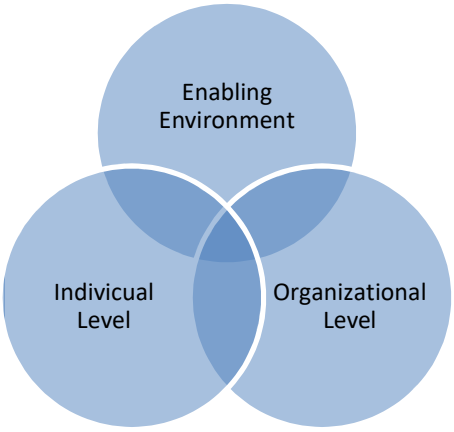


Fig 3.6: Three Levels of Capacity

Capacity Development Process is a very context and case specific process and UNDP (2008) has identified five general steps involved in the process of capacity development, but subject to wide variations. It should also be kept in mind that there is a distinction between capacity building and capacity development (Table 3.8).

- Engage stakeholders in capacity development: .is the first step and work to elicit commitment to and sponsorship from all key stakeholders as the local ownership and participation is critical. Various tried and tested tools for HVRA can be engaged in this stage.
- Assess capacity assets and needs: a thorough assessment of requirements for capacity building has to be made, for instance, if it is drought that the area is prone to, then, assessment has to be made about the farm practices followed by the farming community and their understanding to adopt to new cropping pattern etc.
- Formulate a capacity development program: need to be developed for use with identified stakeholders. It will be more effective to start from some short-term, interventions to generate some “quick wins” or that will enhance known capacity assets and then using more complex or long-term capacity issues.
- Implement a capacity development response: needs to be embedded in strategy formulation and programme planning,
- Evaluate capacity development: To ensure that outputs are translating into outcomes (capacity development) and impact (development goals) an evaluation framework should be established to measure results.

UNDP has outlined the basic principles of capacity development as detailed in Table 3.9.

Fig 3.7: Capacity Development Process (Source : UNDP 2008)

Table 3.8: Capacity Building Vs Capacity Development

Capacity Building	Capacity Development
Narrower scope –capacity development as a means to an end Focuses more on the initial stages of building or creating capacities Often concerned with what outsiders will do to help build capacity and the contribution they can make inked more to technical cooperation and to skills development, training, technology transfer One off or shorter –term interventions	Broader scope –capacity is both the means and the intended outcome in itself Includes both creating and building (or enhancement) as well as the (subsequent) use, management, retention and sustainability of capabilities Seeks to capitalize on existing national capacities as a starting point Understands that capacity development is nationally owned and led, with outside actors providing support to country led processes Includes a mix of approaches and measures, technical and less tangible, formal and informal Longer-term perspective

Source: UNDP 2008

Table 3.9: The UNDP Basic Principles of Capacity Development

It addresses power relations, mindsets and behavior change. It therefore emphasises the importance of motivation as a driver of change. Capacity development is a long-term process. It can be promoted through a combination of shorter-term results that are driven from the outside and more sustainable, longer-term ones that are driven from the inside. It requires sticking with the process under difficult circumstances. The UNDP approach links the enabling environment, as well as organisations and individuals, and promotes a comprehensive approach. It looks beyond individual skills and a focus on training to address broader questions of institutional change, leadership, empowerment and public participation. It emphasises the use of national systems, not just national plans and expertise. It discourages standalone project implementation units; if national systems are not strong enough, they should be reformed and strengthened rather than bypassed. It requires adaptation to local conditions and starts from the specific requirements and performance expectations of the sector or organisation it supports. There are no blueprints. It should link to broader reforms such as those in education, wage structures and the civil service. There is little value in designing isolated, one-off initiatives. It results in unplanned consequences that must be kept in mind during the design phase. These should be valued, tracked and evaluated. It measures capacity development systematically, using good-practice indicators, case evidence and analyses of quantitative and qualitative data, to ensure that objective judgements are made about capacity assets and needs, as well as the progress achieved

Source: UNDP, Supporting Capacity Development: the UNDP Approach, January 2009, page 1)

3.4.3 Relief and Rehabilitation

3.4.3.1 Relief: Disasters are known to have result in extreme losses both in terms of life and also the livelihoods. In the aftermath of the disaster, the effected community is at its nadir in terms of its physical, economical and psychological status. At this state, relief and rehabilitation activities are very significant to help the effected community to restart their journey towards normalcy. The role of governmental and non-governmental agencies to help the community is very significant as community has to fend for itself. The foremost thing for effected community is relief. However, ensuring a timely and effective relief assistance during disaster remains as a major challenge across the world due to size of the effected community that needs assistance, limited time and resources, improper planning and implementation etc. Government of India has developed guidelines about the relief and norms to be maintained while implementing the relief activities (NDMA Guidelines).

Shelter (Relief Camp): The type of response required to meet the needs of people and the households affected by disaster is determined by key factors including the nature and scale of the disaster and the resulting loss of shelter, the weather conditions, the urban/rural context and the capacity of the community to cope. Relief Camps provide necessary security and personal safety, protection from climate and to prevent outbreak of epidemics. The relief camp is also important for human dignity and to sustain family and community life as far as possible in trying circumstance. For the relief camps to be established by the government agencies, guidelines have been developed about the standards that have to be maintained at these camps, for instance, water availability, no of toilets and power back up options, appropriate quantity of fit to human consumption cooked food which is culture specific and as per food habits of the community shall be provided to the camp inhabitants. On the other hand, community based organizations also make the relief camps for the benefit of effected communities.

3.4.3.2 Rehabilitation marks the second phase in the aftermath of the disasters, wherein, the effected local services related to the provision of immediate needs will have to be restored and marks the beginning of a systematic return to pre-disaster status. The term rehabilitation refers to all those actions taken in the aftermath of a disaster to enable basic services to resume functioning and assist effected communities self-help efforts to repair physical damage, restore community facilities, revive economic activities, along with the psychological support and social well-being of the survivors. It is the transitional phase between immediate relief and major long-term development. Three types of rehabilitation process are required to help the effected community;

- **Physical Rehabilitation** includes reconstruction of physical infrastructure, such as, houses, buildings, railways, roads, communication network, water supply, electricity etc. It also comprises short-term and long-term strategies towards watershed management, canal irrigation, social forestry, crop stabilisation, and alternative cropping techniques, job creation, employment generation and environmental protection.

- **Social Rehabilitation:** Social life is an integral part of survival and in most disasters, this fabric gets effected severely and vulnerable groups like the elderly, orphans, single parents with young children, etc., much more vulnerable to disaster aftermath due to lack of adequate support and need special social support to survive the impact of disaster**,** but most often is ignored**.** A realistic recovery plan is needed for this social dimension in the disaster-affected area.

- **Psychological Rehabilitation** The trauma of losing relatives and friends, and the scars of overall shock of the disaster event can take much longer to heal and psychological support programmes be considered immediately after a disaster event so that they could be made a vital part of recovery programmes

To Do Activity
Describe the importance of Preparedness in disaster mitigation measures
List out the preparedness measures undertaken by District Disaster Management Authority in your region. Please list the efforts of civil society, if any.
Describe the importance of appropriate Rehabilitation plan
The importance of preparedness in providing emergency relief with relevant examples from your region

3.5 Post Disaster Need Assessment

Disasters result in abrupt disruptions to the economic activities and also cause severe damage to several components of supply/value chain. Thus, restarting these economic activities requires allocation of significant resources to reconstruct or replace the damaged components and help or assistance from the government becomes crucial to help the affected community to recover and restart the economic progress. Governments do allocate the possible resources to assist the affected population to overcome the negative impact of disasters and implement recovery and reconstruction programs. But it requires reallocation of significant resources from the normal development expenditures and investment and hence, the requirement of fund allocation to for post-disaster recovery and reconstruction should be made in an objective manner so that the reallocation from developmental programs would leave minimal impacts on ongoing developmental programmes (Table 3.10).

As we have seen in previous chapters, India is prone to disasters. Even though several preventive and mitigation measures to reduce the adverse impacts of disasters are made, frequent disasters do cause

significant damages to public infrastructure and also to private assets. But, the procedures for estimating the economic costs of reconstruction or restoration of disaster-affected components, are still in the process of evolving and there are also variations in the procedures adopted in different states, on the other hand, standardization or uniform methodology can help in optimization of estimation of damages in a scientific manner. General practice for estimation of damages is carried out in the following process

- State government declares a particular incidence of natural calamity as disaster
- Revenue departments of effected districts to conduct a damage estimation and submit the report to the state government
- The state government, then declares the quantum of support to the affected communities, in general, guided by the norms prescribed by the Home Ministry.
- Direct benefit transfer of sanctioned support by the government to the eligible affected persons. In the event of the state government is short of funds, a request is forwarded to the central government for support.
- Central government extends support according to the norms if it accepts the request from the state government. However, the state government is at liberty to sanction more relief than the prescribed norms.

Table 3.10: Evolution of Post Disaster Need Assessments Methodologies

Year	Development in PDNA
1965	The decision by UN General Assembly to decide to increase its ability to help the people affected by disasters in view of the increasing trend in the incidences of disasters across the globe
1971	Establishment of the Office of United Nations Disaster Relief Coordinator (UNDRO) to serve as catalyst and coordinator of donors of aid and services. Further, to assist governments in preventing disasters or mitigating their effects by contingency planning, in association with similarly concerned voluntary organizations.
1972	A first-ever full assessment of disaster impacts on the value of destroyed assets and also an estimation of changes in economic flows (indirect production losses) due to the earthquake in the capital city of Nicaragua by the United Nations Economic Commission for Latin America (UN-ECLAC)
1979	Publication of *Disaster Prevention and Mitigation, Compendium of Current Knowledge by UNDRO, defining* the general conceptual framework for assessing disaster effects and impacts.
1991	Publication of standard methodology for the assessment of direct and indirect disaster effects across all sectors of economic and social activity
1990s	Further expansion of the methodology to include the analysis of disaster impact on the environment by the UN agencies such as the Food and Agriculture Organization (FAO), UN-HABITAT, the United Nations Environment Program (UNEP), the Pan-American Health Organization (PAHO/WHO), the United Nations Industrial Development Organization (UNIDO) and others.
2001	Partial adoption of UN-ECLAC methodology for post-disaster need assessment after the Gujarat earthquake
2003	Publication of updated version of Post Disaster Need Assessment with the support of the Government of The Netherlands and the World Bank
2006	Establishment of the Global Facility for Disaster Reduction and Recovery (GFDRR) by the World Bank and efforts to further refine UN-ECLAC to include the analysis of the impact at the personal or household levels and to standardize the quantitative estimation of recovery and reconstruction financial requirements across all sectors of social and economic activity.

(Source NIDM Guidelines)

3.5.1 Framework for PDNA

Rescue efforts are the immediate priority in the post-disaster phase wherein every possible resource to be engaged in saving lives, treating the injured ones. Conducting urgent short repair activities and provide access to basic services are taken in the second phase of post-disaster activities. Cumulative experience from many countries indicated significant value to conduct a post-disaster assessment of socio-economic and environmental effects within the disaster-affected area. Such assessment, including the estimation of physical damage and economic losses across development sectors and all the related social impacts, could help the State to proper identification of reconstruction and prioritize. A comprehensive assessment is, therefore, the foundation for subsequent reconstruction and recovery activities in the affected area. Post-disaster assessment is carried on two major axes, viz., a) the cost of the physical, durable assets that are destroyed /damage, and b) the value of changes or disruptions in the production of goods and services arising from the disaster. NDMA (2019) has suggested the general process as detailed in Table 3.11.

Table 3.11: General Steps and Results of an Assessment

The following general steps are typically conducted in a post-disaster needs assessment:
1 Collect baseline information for all sectors (Complied by the Central Statistical Organization, GoI) 2. Assess damages and losses for all sectors (effects) 3. Assess disaster impacts (social, macro-economic, cross-cutting issues) 4. Define recovery strategy (prioritized needs, programs, and projects)
The results of the assessment provide helpful information to understand the needs and priorities for recovery, including:
• Total value of destruction in physical assets (damage) and changes (losses) in flows of the economy • Distribution of damages and losses by ownership (government or private) • Identification of most affected sectors • Geographic distribution of disaster effects • Impact of the disaster at macro-economic and at personal/household levels • Estimates of post-disaster needs for recovery, reconstruction and disaster risk reduction

(Source NIDM)

Estimation of financial requirements to achieve recovery and reconstruction of the affected areas and population, will be made based on the findings of damage assessment and evidence-based estimations and involve a number of activities that would enable returning economic and living conditions to non-disaster conditions.

3.3.1.1 Non-Negotiable Aspects of PDNA: Following are three non-negotiable aspects of every PDNA, viz.,

- Every disaster is a new one and brings misery and hardship to the affected community. The extent of hardships is a product of the magnitude of the disaster and the vulnerabilities of the human settlements and activities that prevailed in the affected areas during the times of disaster. Hence, PDNA has to be analyzed on its own characteristics and needs. Under no circumstances, previous PDNA can be used.
- The value of post-disaster needs for recovery is usually lower than the total value of production losses or higher production costs, and that only a fraction of their estimated value is required to re-start the production process and eventually achieve normal or non-disaster levels of development. On the other hand, that the value of post-disaster reconstruction needs will always be higher than the estimated value of destroyed assets because improved, disaster-resilient norms are required to avoid their destruction whenever other natural events occur in the future; thus, reconstruction needs

will always have a higher value than the estimated value of the damage.

- PDNA for recovery and reconstruction should be estimated for the entire affected society and economy. Failing to do so, post-disaster recovery and reconstruction will not achieve its intended overall targets, and the solution of problems in selected sectors may be impeded or retarded by the non-attention given to problems in other sectors.

3.5.1.2 Core Components of PDNA: Four elements form the core of PDNA, viz.,

- **Pre Disaster Context and Baseline Information:** Examination of pre-disaster conditions pertaining to socio-economic cultural, financial and political systems serve as a baseline to compare with post-disaster conditions in the affected regions.Information pertaining to various sectors such as literacy rates, malnutrition and food insecurity,poverty levels, access to potable water and sanitation facilities, education facilities and schoolenrolment, health conditions etc can be components of baseline information. If the baseline data is not available, measures like the discussion with key informants;Visual impressions of unaffected areas and its comparison with the affected areas; comparison of satellite imageries of pre, post-disaster situations, may also be considered to create the baseline.

- **Assessment of Disaster Effects**: For the majority of the effected community, due to their lower resilience capacity, support from the government in post-disaster phase becomes vital to recover from the adverse impacts of disaster and hence, utmost importance shall be given for need assessment. In some disastrous events, the extent of damage is so severe that the global community may also step in to help the affected countries to recover, provided the need assessment is carried out by the affected country. Thus, the proper assessment PDNA is very important. There is a general agreement that disasters impact almost every sector either directly are indirectly and the extent of damage is dependent on the vulnerability of that sector to disasters and that impact both at macro and micro levels. The impacts will penetrate to personal or household level at the micro-level and it is important to capture the impact at micro levels as well. At the sector level, disaster effects are grouped into two main types, viz.,

  Damages: the value of physical, durable assets destroyed by the disaster. At a personal level, damages refer to the value of destroyed physical, durable goods or assets owned by individual persons or households; and
  Losses: Changes in economic flows arising because of the disaster, which normally include the value of production of goods and services that will not be obtained and the associated higher costs of production are termed as losses. At a personal level, the losses include a decline in income as a result of disruption of livelihood activities and employment, together with the associated higher costs of living due to difficulties or higher costs of access to goods and services.

- **The Assessment of Disaster Impacts**: By nature of definition, one can say that damages occur at the time of the disaster, while losses would occur over time until recovery or normalcy is achieved and till then the impacts of disaster will remain. The impacts may result in a reduction in the capacity of production of goods or a decline in the capacity and actual provision of services, this may result in a decline in the value of Gross Domestic Product (GDP). At personal or household level, disaster may result in the reduction in the capacity of that household to access to goods and services and hence financial requirements to achieve recovery of personal income, access to basic services for the population, and production levels should be given due attention. Damages and losses (the effects of disasters) will have their longer-term consequences, on varying time scale of short-, medium-, and long-term bases, on both macro-economic and on human development (social impacts) aspects,

- Macro-economic impacts: PDNA assessment of effects on macroeconomic impacts will consist of flowing;
    - Impact on gross domestic product or gross regional domestic product (GDP or GRDP), includingan assessment of relative impacts on various sectors.
    - Impact on Fiscal Budget due to disaster as government revenues may decline (lower economicactivity resulting in lower tax collections), while expenditures will increase.
    - Impact on Balance of Trade and Payments as exports may decrease due to production losses,while imports may increase to replace lost assets and production.
- *Human and social development impacts* will cover the difference between pre-disaster and post-disaster levels of the quality of life or human development until the economy and community have recovered and return to the pre-disaster levels.

- **The Recovery Strategy and Determining Sector Recovery Needs**: are estimated values of activities required for post-disaster recovery and reconstruction, including the possible measures to mainstream Disaster Risk Reduction (DRR).
- **Recovery** needs are those required for the restoration of affected facilities, livelihoods, including DRR efforts, comprise programs and projects to restorepersonal and family income; essential services or lifelines; and production activities in affected sectors.
- **Reconstruction** involves the construction or replacement of damaged physical structures, and the restoration of local services and infrastructure and may involve longer-term activities, such as New infrastructure like bridges, roads, etc. and Preparedness and mitigation measures

3.5.2 Disaster Losses and System of National Accounts

United Nations has evolved a common 'System of National Accounts' to measure economic development. The purpose of this system is to enable a measuring method on an annual basis, the value of capital stocks and of production flows present in any given country, for the country as a unit and also for sub-national or state geographical divisions. This system was adopted by member countries in the year 1948. This system is a tool that enables to measure the level of economic growth, changes in consumption, savings, investments, debt and wealth for the total economy of a country within all sectors of activity and permits to

(i) forecast the future growth of the economy;
(ii) analyze the impacts of alternative policies that may be adopted by the government on the economy and its sectors, and
(iii) estimate the possible impact of a disaster or any other type of shock tothe economy and its sectors.

Government of India has entrusted the Central Statistical Organization (CSO) in the Ministry of Statistics and Programme Implementation (MSPI) of India, with the task of keeping up to date the System of National Accounts for the country. The CSO accordingly collects information at the national level and publishes an annual Statistical Yearbook that summarizes the information required as a baseline for any post-disaster needs assessment. Similarly, equivalent state-level organizations collect information at sub-national information or at the state level and bring out the annual publication in the form of state statistical abstracts. Various sectors of economic activities are considered by the CSO for the use in the System of National Accounts of India (Table 3.12). However, the list of social and economic activities or sectors used in the System of National Accounts in India does not coincide with the organizational structure of the central and state governments. In fact, in some sectors defined in the national accounts, several ministries and departments may be involved in the discharge of government duties. Since the use of the national accounting system is a pre-requisite for the valid application of the procedures for estimating disaster effects and impacts, the table shows the mapping of government ministries and departments that are included within the boundaries of the sectors of activity as per the national accounts.

Table 3.12: Sectors under Natural Accounting Scheme and Responsible Ministries

SL	Sectors as defined in the System of National Accounts	List of Activities carried out by Different Government Ministries and Departments1
1	Agriculture, forestry and fishing;	Forestry and Fisheries Rural Development Agriculture and Allied Activities Irrigation Animal Husbandry Environment and Forestry
2	Mining and quarrying;	Oil and Gas Mining of Minerals
3	Manufacturing;	(Commerce) and Industries Small Scale Industries
4	Electricity and gas;	Power Sector Water Resources
5	Water supply, sewerage, waste management;	Public Health Engineering
6	Trade, hotels and restaurants;	Tourism Commerce
7	Transportation and communications;	
8	Financing, insurance, real estate and business services; and	Housing (Rural, Urban as well as Public and Private)
9	Community, social and personal services	Education Health Labour Women and Child2 Social Welfare Urban Development GoI Installations at State Level Municipal Corporation

Source: NIDM 2019

To Do Activity

Describe the Post Disaster Need Assessment process
What is National Account System and how it caters to the Natural Disasters
Describe the Important elements of PDNA

Summary of Chapter

Model Questions

Reading Materials

- IPC 2004
- Santosh Kumar and ShekherChaturvedi 2019. HANDBOOK POST DISASTER NEEDS ASSESSMENT INDIA. *Published by* National Institute of Disaster Management, Ministry of Home Affairs, New Delhi - 110 001. ISBN 978-93-82571-26-1
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Chapter 4 Approaches to Disaster Risk Reduction

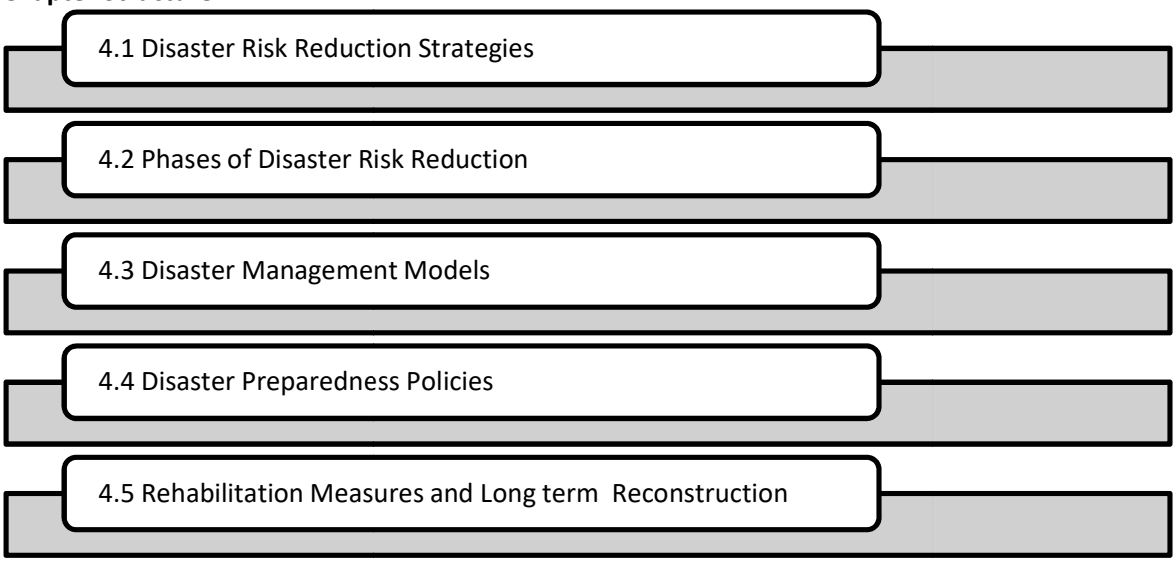
Introduction

Increasing trend in the incidence of natural disasters and exposure has made the UN General Assembly to declare the decade of 1990 as International Decade of Natural Disaster Reduction (IDNDR), and chalk out various other programs to reduce the damages due to natural disasters. Focus of these measures was on the awareness and upgradation of technical skills. Since then, the discipline of knowledge in disaster management is growing and the level understanding is increasing. United Nations Conference on Environment and Development at Rio in 1992 also known as Earth Summit and the Agenda 21 can be termed as the beginning of the road to the systematic approach for disaster management. One of Agenda 21's themes is protecting and promoting human health and reduction of health risks from environmental pollution and hazards. It was followed by the 'Yokohama Strategy for a Safer World', emphasizing the close linkages between disaster losses and environmental degradation, articulated in Agenda 21, and it highlighted how the absence of disaster risk reduction is a hindrance to development. The United Nations International Strategy for Disaster Reduction (UNISDR) was established in 2002 and Hyogo Framework for Action (HFA) adopted in 2005 during the 2ndWorld Conference on Disaster Reduction. The framework called for the "substantial reduction of disaster losses, in the lives and in the social, economic and environmental assets of communities and countries". The 'Mauritius Strategy of Implementation', 2004 recognized the need for a preventive approach towards natural disasters and called for the integration of risk management in development policies and programs. The United Nations Conference on Sustainable Development in 2012 looked towards how to take action on addressing the social and environmental determinants of health, disaster risk reduction measures, and resilience building strategies in the lens of sustainable development. These global instruments demonstrate a movement leaning towards the integration of disaster risk management, health, and sustainable development. Thus, with increased understanding about root causes, drivers and factors that cause natural disasters and vulnerability to them, the strategies to deal with them was also modified in line with increasing understanding of disasters. This section presents a brief overview of the various approaches that were adopted.

Objectives

- To help in understanding the different strategies of disaster management
- To provide bird eye view of different models in disaster management
- To explain Importance of aspects like Early warning, preparedness
- To explain concepts of rehabilitation and reconstruction

Chapter Structure



4.1 Disaster Risk Reduction Strategies

Taking the stock at mid-way on progress made in the status of disaster reduction during the Decade International Decade for Natural Disaster Reduction, at Yokohama, Japan, it was agreed that the this initiative has led to significant improvement in the disaster management, but at the same time, there could further improvements. During the evaluation, it was observed that the following were main accomplishments and failures:

- Awareness of the potential benefits of disaster reduction is still limited to specialized circles and has not yet been successfully communicated to all sectors of society
- On the other hand, during activities in training, technical applications and research at local, national and international levels and in regional cooperation, have had positive results in some regions in reducing disaster losses;
- More importantly, as suggested by UN General Assembly for the creation of the organizational framework both at national and international level showed significant progress, and laid the basis for preventive and preparedness efforts.

It was agreed that the positive results during the first half of the Decade, although unevenly, if proper stimulus is provided by means of recognition, consolidation and acceleration, the goals and objectives can be met and can contribute to the development of a global culture of prevention. It was also felt that

- a comprehensive approach towards disaster management is required
- a strong need to strengthen the resilience and self-confidence of local communities to cope with natural disasters through recognition and propagation of their traditional knowledge, practices and values as part of development activities;
- the concept of the disaster reduction should be enlarged to cover natural and other disaster situations including environmental and technological disasters (NaTechs) and
- their interrelationship which can have a significant impact on social, economic, cultural and environmental systems, in particular in developing countries.

These observations and recommendations has led to the first ever systematic attempt by the global community for reducing the disaster risk and the impact in the form of adoption of the “Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and

its Plan of Action" (Yokohama Strategy), 1994. This Strategy has provided landmark guidance to on reducing disaster risk and the impacts of disasters. It paved the way for paradigm shift of earlier approach of disaster response as it provides only the temporary relief but at a very high cost. Through the adoption of Yokohama Strategy, global community has adopted the following strategy for disaster prevention, mitigation and preparedness during the period of 1995 to 2005,

- Natural disasters do not respect borders and hence, the regional and international cooperation is required in mitigating disasters.
- Encouragingthe community involvement in order to gain greater insight into the individual and collective perception of risk, understand the cultural and organizational characteristics of society and its behaviour and interactions with the physical and natural environment. (understanding the risk).
- Recognize and strengthen traditional methods and explore new ways to live with such risk, and take urgent actions to prevent as well as to reduce the effects of such disasters.
- Developing countries affected by desertification, drought and other types of natural disasters are also equally vulnerable and insufficiently equipped to mitigate natural disasters.

During the period from 1995 to 2005, global community has witnessed several disasters both natural and also anthropogenic. It was also observed that disaster risk is increasingly of global concern and its impact and actions in one region can have an impact on risks in another, and that the Intensity of these disasters was magnified by various drives such as

- changing demographic,
- technological
- socio-economic conditions,
- unplanned urbanization,
- development within high-risk zones,
- under-development,
- environmental degradation,
- climate variability,
- climate change,
- geological hazards,
- competition for scarcer sources, and
- epidemics HIV/AIDS etc.

Further, the review of implementation of the Yokohama Strategy, indicated that

- Need for more systematic action to enhance national and local capabilities to manage and reduce risk
- disaster risk reduction efforts can be underpinned by amore pro-active approach to informing, motivating and involving people in all aspects of disaster risk reduction
- In view of the scarcity ofresources allocated for the realization of risk reduction objectives, through cooperation and financial mechanisms, better management of resources can help more effective disaster risk reduction.

For future course of action, following specific gaps and challenges were identified in the five main areas:

a) Governance: organizational, legal and policy frameworks;
b) Risk identification, assessment, monitoring and early warning;
c) Knowledge management and education;
d) Reducing underlying risk factors;

e) Preparedness for effective response and recovery.

The Hyogo Framework for Action (HFA) was focused on *the substantial reduction of disaster losses, in lives and in the social, economic andenvironmental assets of communities and countries.* Further, the HFA has been woven around the theme of disaster risk reduction and has structured its priorities around it,

a) **Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation**: Member countries to develop policy, legislative and institutional frameworks for disaster risk reduction. In response, GoI has enacted National Disaster Management Act in 2005 and also the legislations at state level. Further, institutions to deal with disaster management were established, for instance, National Disaster Management Authority (NDMA) at central level and State Disaster Management Authorities (SDMA) at state level.

b) **Identify, assess and monitor disaster risks and enhance early warning** invariably, for any step to reduce the disaster risk and for promotion of a culture of resilience, starting point would be to understand the physical, social, economic and environmental vulnerabilities to disasters. Based on that understating, actionscan be initiated.

c) **Use knowledge, innovation and education to build a culture of safety and resilience at all levels:** Vulnerability to disasters can be substantially reduced if people are well informed and motivated, but, it requires the collection, compilation and dissemination of relevant knowledge and information on the potential disasters. In the vulnerable regions, awareness programmes for the community are initiated to by the respective authorities.

d) **Reduce the underlying risk factors** Detailed risk profile can help to draw plans to reduce thelevel exposure and thus overall risk due to disasters.

e) **Strengthen disaster preparedness for effective response at all levels** state of preparedness helps to a great extent to reduce the adverse impacts of disaster and losses.

The *Sendai Framework for Disaster Risk Reduction* (SFDRR)articulates a very specific goal: to considerably diminish disaster risk and losses of lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries. In order to achieve this goal, countries must commit and promote involvement at all levels in the implementation of measures that will serve to combat vulnerability to disasters and increase awareness and preparedness for recovery and response. Furthermore, seven targets were established for countries to achieve by 2030; and aim to

- substantially reduce global disaster mortality,
- substantially reduce the number of affected people,
- reduce direct disaster economic loss in relation to global gross domestic product,
- substantially reduce disaster damage to critical infrastructure and disruption of basic services, including health and educational facilities,
- substantially increase the number of countries with national and local disaster risk reduction strategies by 2020,

- substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation under the present framework and
- substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people.

The SFDRR stressed that the primary responsibility for the prevention and reduction of disaster risk lies with individual states, but emphasizes that this responsibility can only be carried out through cooperation with other States at bilateral, regional, and global levels. Some of the other key areas highlighted under the framework were the importance of the development and use of geographic information systems, risk maps, and the integration of disaster risk assessments into land-use policy development and implementation, including urban planning.

To Do Activity
• Explain the focus of Hyogo Frame for Action • Mention the major changes in Sendai Framework for Disaster Risk Reduction from that of Hyogo Framework • Describe the essential features of Indian disaster management

4.2 Phases of Disaster Risk Reduction

In the theoretical construct of Disaster Risk Management, the 'disaster cycle', is marked by prescribing separate phases, on ground, most of the times, it is very difficult to draw a distinct line between these phases. The disaster phases may overlap, be simultaneous, and not water tight compartments. Attempts have been made organize the knowledge, for instance, Lowell Carr (1932) attempted to categorise disaster into four phases.

- The preliminary or prodromal period is the first phase. Here, underlying forces gear up to cause collapse.
- Second Phase, the dislocation and disorganisation phase, which refers to deaths, injuries and other losses.
- Third Phase, the readjustment and reorganisation phase, which includes community response, culture, morale, the speed to cope up and its complexities.
- Fourth Phase (or the confusion-delay phase), the period between the disaster event and the actual operation of emergency plans.

Powell (1954) classifies seven periods of disaster:

- pre-disaster conditions,
- warning (precautionary active),
- threat,
- impact,
- rescue,
- remedy and
- recovery.

At grass root level, both the pre-and post-disaster phases may occur at the same time, and presents a terrain where a multitude of dynamic forces operate and needs to be managed during the pre-disaster phase, the actual occurrence of disaster, and even during the post-disaster phase, for instance, the drought. However, the agencies that are entrusted with disaster management in India, viz., the National Disaster Management Authority (NDMA), the National Institute of Disaster Management (NIDM) have

adopted a clear distinction between pre and post-disaster phases and have structured the National Disaster Management Plan (NDMP) accordingly. NDMA marks the period before disaster occurrence as the capacity building phase wherein measures for prevention, mitigation and preparedness are consolidated. The post-disaster period includes the period of response, assessment, immediate relief, reconstruction, and rehabilitation of the disaster impacted communities.

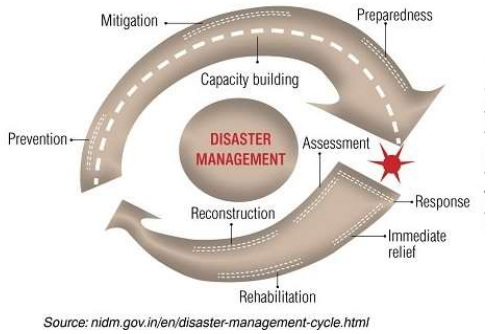


Fig 4.1: Different Phases of Disaster – NDMA
Source: nidm.gov.en/disaster-management-cycle.html

Both the National Disaster Management Plan (NDMP)and State Disaster Management Plans (SDMPs) follows a similar cycle representing the phases of disaster. However, to prevent disasters—preparedness and prevention may occur simultaneously and preparedness may even take place before mitigation. Reconstruction can overlap with preparedness, whereby disaster resistant techniques are adopted to minimise the impact of disasters. Some elements of rehabilitation can also be embedded in the pre-disaster phase. These systems of operation are multidimensional.

Fig: : Phases of disaster as Adopted in National Disaster Management Plans
Source: nidm.gov.in/PDF/Disaster_about.pdf

National Institute for Disaster Management (NIDM), on the other hand, divides the phases of disaster into two primary groups:

- pre-disaster risk reduction phase, which encapsulates prevention, mitigation and preparedness; and
- post-disaster recovery phase, which encompasses response, recovery and development.

Fig 4.3: Different Phases of Disasters as per NIDM
Source: nidm.gov.in/PDF/Disaster_about.pdf

Purpose of marking different phasesareonly to make the management plans more effective and to reduce the adverse impacts of disasters. Breaking of disaster cycles into several components for ease of handling remains the central focus.One of the characteristic features of resilient communities can be found having overlapping disaster phases with reduced recovery, reconstruction and rebuilding phase and a larger component in the prevention, mitigation and preparedness phase. It is vice versa for less resilient communities. The preparedness phase for the communities is also subject to shrinkage, owing to the already well established structure prepared to deal with disasters. The organised structure of DRM can potentially be disorganised with intervention of unfamiliar disaster types. For example, issues of climate change can create newer risks in an already flood prone area.

Post Disaster Phase: Each disaster is a unique event and causes severe hardship to the effected community and may take long time before that community may reach the quality that was existing before the disaster. There are several phases that unfold as communities begin to rebuild their lives after disasters.

- **Search and Rescue** Immediately after the disaster, the initial search requires a fast response and can last for hours or even days after the disaster in order to save lives in imminent danger. Professional emergency-response such as National disaster Relief Force teams are entrusted with this work. Within a few days, the work turns toward providing support to the survivors.

- **Emergency Relief** In the immediate aftermath of a disastrous event, effected community needs food, water, shelter, and medicines and to meet the basic survival needs, the emergency relief phase begins. Those with severe injuries need urgent medical help. After an initial assessment of the situation and the needs of affected communities, state authorities tries to mobilise the resources and also work in tandem with civil society organizations.

Length of emergency relief depends on the nature of the emergency, magnitude, preparedness, vulnerability and accessibility of the affected location, availability of the resources at hand. The relief phase of a disaster transitions into the recovery phase, with people no longer worried about survival but turn to rebuilding their lives.

- **Early Recovery marks a phase wherein the** affected population is in a relatively stable and safe environment of a temporary or transitional shelter. With basic needs like food, water medicines are taken care, they may not have yet recovered fully, but they have begun to adapt to a "new normal." Length of this phase depends on vulnerability, access to resources, adaptability, and other considerations.

- **Medium to Long-Term Recovery marks the** building permanent physical structures to replace tents or temporary structures as does restoration of social structures. With permanent housing is being rebuilt, the social fabric of communities is strengthened life finally beginning to feel stable once more.

4.2.1Early Warning System Change is a natural phenomenon. But, changes, if it too sudden, may result in adverse impacts. As a change, itselfcan not be controlled, but efforts can be made to reduce the extent of the damages. The adage that 'forewarned is forearmed' is very apt and for the Indian context, as its economy is farm-centred and heavily influenced by climatic conditions. Every year, we witness numerous instances of significant economic losses and loss of life due to natural events such as floods, cyclones etc.Early Warning Systems serve the purpose of reducing the negative impacts or preparing the vulnerable communities to the impending changes to the extent possible. Early warnings would be more effective if the vulnerable stakeholders have the response plan as well. Of late, the technological developments in meteorological forecasts have seen rapid advancements. Except for a few natural phenomena (like an earthquake), most of the disasters could be forecasted (even the lightening) with reasonable certainty. If only these forecasts reach end-user in time, there could be significant savings. Towards developing such a seamless system and flow of information, the government has initiated several measures.

The term 'Early Warning' is generally used to describe the provision of information on a dangerous emerging hazard. It enables advance action to reduce the associated risks. It may address natural, geophysical, biological hazards, complex socio-political emergencies, industrial hazards and personal health risks, among many others. United Nations International Strategy for Disaster Reduction (UNISDR) defines early warning as 'the provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response' (UNISDR 2004). Thus, EWS play an important role by pre-warning the vulnerable community about impending hazard and enables to take appropriate measures to mitigate the disaster. It was internationally acknowledged that had Early Warning System (EWS) for Tsunami was in place, devastation by the tsunami in the Indian Ocean in 2004 which took about 220,000 human lives would have been far less. Indian Ocean Tsunami in 2004 has brought the international focus on the inadequacy or lack of such EWS and stressed the importance of it in disaster risk reduction (DRR). EWS provides a unique opportunity to empower individuals and communities with information that could help them to act in sufficient time and in an appropriate manner to reduce the losses. Thus a proper EWS can lessen the negative economic, environmental and social impacts of extreme events through measures to prevent or mitigate their effects (UN 2005).

EWS was given its due importance as one of the most important thematic areas of Hyogo Framework for

Action (HFA). HFA has stressed for EWS. In its Priority No 2, - Identify, assess and monitor disaster risks and enhance early warning, HFA has recommended that

> "(d) Develop early warning systems that are people-centred, in particular systems whose warnings are timely and understandable to those at risk, which take into account the demographic, gender, cultural and livelihood characteristics of the target audiences, including guidance on how to act upon warnings, and that support effective operations by disaster managers and other decision-makers.

As a successor instrument to the HFA, the Sendai Framework (SFDRR), after reviewing the progress in achieving the disaster risk reduction, also stressed the importance of EWS and has increased its importance by making it as one of the seven targets to be achieved as Goal # 7

> "Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030". (para 17, g). In addition, SFDRR has prioritized EWS as its Priority No. 1

The purpose of EWS, as envisaged in these Frameworks is to reduce the disaster risk and thus help in better disaster management. The primary objective of preparing and delivering EWS is to enable the end-users to make better decisions by using weather and climate information. End-User community or stakeholders may vary from government authorities to the public and EWS should be able to cater to the specific needs of each of the stakeholder groups. The factor of time attains crucial significance in disaster management as time becomes a limiting factor in most of the disaster situations and EWS should consider the time factor very carefully. For instance, in case of Earthquake, EWS are not possible with existing technology, in case of lightening, the EWS provides only a few minutes time before they strike. Advanced technologies have enabled us to predict accurately about the formation of cyclones in advance, at times, more than a week before. Further, the technology has also helped us to predict with reasonable accuracy about its location of landfall and also possible areas of flooding. To generate intended reactions from stakeholders in the wake of a disaster, EWS must be people-centred and integrate four elements, viz., a) risk knowledge; b) technical monitoring and warning service; c) communication and dissemination of warnings and d) community response capability.

> **Risk Knowledge**: Adequate assessment of vulnerabilities to various disasters and risks is the beginning point for proper disaster management. Based on historical experience also HVRA can be made and pattern, trend and extent of risk from disasters can be profiled. Such profile helps to prioritize the early warning system to optimize its utility and also to guide preparations for appropriate mitigation or prevention.
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> **Monitoring and Warning Service**: Monitoring network for various parameters provides the crucial information which helps in predicting the weather elements. Constant monitoring of possible disaster precursors is necessary to generate accurate warnings on time. Therefore, higher resolution, both spatial and temporal, higher would be the accuracy of prediction. Adopting a monitoring network that collects information about many hazards and also involves various monitoring agencies is most effective and economical as well. Equally, important aspect is analyzing the monitored data to develop the prediction and depending on the level of expertise, it can be developed in-house or outside assistance can be taken.
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> **Communication and Dissemination**: Once the prediction is made, then it is of vital importance to convey the same to end-user or those at risk, in a very clear and understandable message/warnings. For end-user to initiate the appropriate actions, the messages should provide them with clear, useful information. For reaching out to the end-user community, well-established channels of communications should be in place, and these channels must have Regional, national and community level reach.

Response Capability: Once the end-user community receives the Early Warning Message, communities must be in a position to understand their risks and capable of reacting. Sustained efforts to bring awareness can help to take a community to that level. Building up a prepared community requires the participation of formal and informal education sectors, addressing the broader concept of risk and vulnerability.

Profile of EWS in India Given its importance, India has a tradition of undertaking monitoring and forecasting the weather conditions and advising the concerned stakeholders through meteorological Forecasts, Alerts, Early warnings and advisory communication. Predictions were also made in the category of Long-Range Forecast (LRFs). The first operational LRF for seasonal monsoon rainfall was issued on June 4, 1886 and was based on antecedent Himalayan snow cover (Blanford 1884). There have been many refinements in the LRF techniques, including the 135 multiple regression technique introduced by Sir Gilbert Walker in 1910.

India Meteorological Department (IMD), was entrusted with the task of providing meteorological services, began regular weather services for farmers in 1945 in the form of "Farmers' Weather Bulletin" and broadcasts through All India Radio (AIR) in regional languages. In 1971, on the recommendation of the National Commission on Agriculture, IMD launched Agro-Meteorological Advisory Services (AAS), a comprehensive tool tailored to farmers' need and has steadily improved since. For district level, AAS are prepared containing past weather, forecast for 5 days ahead and a weather-based agro-meteorological advisory that includes pest and disease information and three dissemination channels – mass media, group awareness campaigns and individual contacts were used to reach more farmers. However, weather condition being local or area-specific, higher the resolution of data, better would be the benefits from such weather-related communication services. Thus the monitoring network of IMD was falling short of the desired level.

Evolution of EWS Services Weather forecasting is the attempt by meteorologists to predict the state of the atmosphere and the weather conditions that may be expected. Accurate weather forecasts can tell a farmer the best time to plant or when to apply fertilizers etc. The Greek natural philosopher Theophrastus wrote a Book of Signs, in about 300 B.C. listing more than 200 ways of knowing when to expect rain, wind, fair conditions, and other kinds of weather. Scientifically-based weather forecasting was not possible until meteorologists were able to collect data about current weather conditions from a relatively widespread system of observing stations and organize that data in a timely fashion. By the 1930s, these conditions had been met. Vilhelm and Jacob Bjerknes developed a weather station network in the 1920s that allowed for the collection of regional weather data. The weather data collected by the network could be transmitted nearly instantaneously by use of the telegraph, invented in the 1830s by Samuel F. B. Morse, marking the beginning of the age of scientific forecasting, also referred to as synoptic forecasting, was underway. National Weather Service (NWS), a division of the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, of USA, has lead the initial efforts. Current day Global weather data are collected at more than 1,000 observation points around the world and then sent to central stations maintained by the World Meteorological Organization, a division of the United Nations. The basis for long-range forecasting is a statistical analysis of weather conditions over an area in the past. Numerical weather prediction refers to forecasts obtained by using complex mathematical calculations carried out with high-speed computers. Based on mathematical models of the atmosphere, meteorologists select a group of equations that describe the conditions of the atmosphere as completely as possible for any one location at any one time.

Institutional Arrangement Indian Meteorology Department (IMD) began regular weather services for

farmers in 1945 in the form of a "Farmers' Weather Bulletin" and broadcasts through All India Radio in regional languages. In 1971, on the recommendation of the National Commission on Agriculture (NCA), it launched Agrometeorological Advisory Services (AAS), a comprehensive tool tailored to farmers' need and have steadily been improved since. Today, IMD is implementing operational agrometeorological schemes across the country under a five-tier structure:

- Top-level policy planning body in Delhi
- Execution by the National Agromet Service headquarters in Pune
- Coordination and monitoring by State AgrometCentres
- Definition of the agro-meteorological zone
- District or local level extension and training for input management advisory service

This structure includes State Agricultural Universities, Institutes of Indian Council of Agricultural Research and Indian Institutes of Technology. The application of weather forecasts to generate crop advisories requires the definition of a spatial domain of validity and a temporal range as well as accuracy. At the district level, such are prepared containing past weather, forecast for 5 days ahead and a weather-based agro-meteorological advisory that includes pest and disease information. The phenological stages of plant development are included in crop-specific advisories to offer farmers guidance on cultural practices. All the information is geared to help farmers maximize output and avert crop damage or loss. Agromet Advisory Services use three dissemination channels – mass media, group awareness campaigns and individual contacts – to reach more farmers.

To Do Activity
• Describe the Different phases in Disaster management • Explain the significance of Preparedness in reducing the disaster risks • Provide a detailed account on Early Warning systems

4.3 Disaster Management Models

"A theory is a general explanation of particular phenomena that has withstood many attempts to disproveit. Because of the evidence supporting the explanation and because it hasn't been refuted, a theory will be widely accepted as provisionally correct within the science community"(Tarrant 2002). A model is an application of theory—a simplified representation of the real world. A model is usually a tool developed for specific purposes—either to aid understanding, or for some application, such as to estimate or manage risk. Whether it is conceptual, physical, mathematical, statistical, or visual, it is a representation of reality; it is not the "real" world but rather a construct to aid us in understanding it. For example, weather forecasts are better fit the conceptual model of weather patterns only, not with real world. Another example is Wind Tunnel experiments, are used to test the response of structures to strong winds and results may be used to understand the response of structures to the strong winds. However, care should be taken that in process, no errors such as Type I, Type II and Type III Errors were made.

Table 4.1: Type I and II Errors

		Reality	
		Hypothesis = true	Hypothesis = false
		Conclusion	
Conclusion	Hypothesis = true	Accept hypothesis = Success	Accept hypothesis = Type 2 error
	Hypothesis =	Accept Hypothesis = false – Type 1 Error	Accept hypothesis = success

	false		

If the strategies designed to reduce risk may actually increase it, they have often fallen into thetrap of Type III error and the well-known Levee Effect is an example. It refers to increaseddevelopment in flood-prone areas after the construction of dykes or dams because peoplefeel protected. Ultimately, however, when a flood occurs, the disaster can be all the greater and flooding in coastal cities like Mumbai and Chennai represent such Type III errors. Models help us to reduce these errors. The disaster models can be broadly grouped in to two categories, a), those oriented towards management and b) those focused on understanding the causes of disasters. Comprehensive Emergency Management and the Incident Command System, are two models belong to the former category.

a. Comprehensive Emergency Management Models (CEM): This model is widely adopted in the field of emergency management and primarily used in USA and Canada. Differing from earlier models that have the emphasis on preparedness and response, CEM model was developed in the 1980s with four major pillars, viz.,

- **Mitigation** long-term actions that reduce the risk of natural disasters, such as constructing dams and prohibiting people from building homes or businesses on slopes.
- **Preparedness** involves planning for disasters and putting in place the resources needed to cope with them when they happen, such as stockpiling essential goods and preparing emergency plans to follow in the event of a disaster.
- **Response** actions to be taken after a disaster has occurred. The activities of police, firefighters, and medical personnel during and immediately after a disaster fall into this category.
- **Recovery** encompasses longer-term activities to rebuild and restore the community to its pre-disaster state, or a state of functionality. This is also a good time to engage in activities that reduce vulnerability to future disasters, such as strengthening building codes or modifying risky land-use policies.

b. Integrated Emergency Management (IEM) Model: Developed in United Kingdome, similar to CEM models, this model covers six areas, with resilience is stressed at every area, viz.,

- **Anticipation**: While the primary responsibility for response is at the local level; higher levels of government is involved measures of anticipating the disaster.
- **Assessment stage**: concerned agencies are required to conduct risk assessments of potential hazards, and to identify preventative measures. Such planning needs to be flexible and to consider worst-case scenarios.
- **Prevention** is mandated by legislation, regulations, codes, and guidance documents that set standards for the management of various kinds of threats.
- **Preparation** includes planning, training, and exercising, and clearly defining roles and responsibilities. These plans need to be integrated within organizations as part of an overall management strategy.
- **Response** must be collaborative and coordinated; organizations must have clearly identified trigger points that activate their emergency management plans.
- **Recovery** planning should begin as soon as possible and should fully involve the affected community. IEM emphasizes using common consequences of incidents, as opposed to considering various causes; in this sense, it is like an all-hazards approach. 15

II. Models for Understanding Risk: This set of models help in understanding the factors that influence the risk and are different in nature, viz.,

a. **Pressure and Release (PAR) Model**: First published in 1994 in a book 'At Risk', the PAR model is based on the notion that a disasters occur when a hazard interacts with vulnerability and provides a very useful model to understand the way in which social–economic and cultural forces create vulnerable conditions. This model helps to understand the socio-economic context of a hazard,- how the root causes (such as poor governance) and dynamic pressures (like rapid change and low capacity) and unsafe conditions (low coping capacity/economic status), combine with a natural hazard to create a disaster. This models helps to understand the high mortality in case of high intensity but low frequency incidents like Latur Earthquake, where the economic conditions of the people is low and even the construction of houses was unsafe. The incidence of earthquake has led to several folds higher mortality due to these two factors.

Table 4.2: PAR Model

Progression of Vulnerability	Dynamic Pressures	Unsafe Conditions	→ ←	Natural Hazards
Low access to resources	Lack of education, training, investment	Poor construction standards	Disasters Risk= hazard x vulnerability	Earthquake
Limited Influence in decision making	Rapid urbanization	Unsafe infrastructure		Cyclones
Poor governance and a weak economic system		Poverty		Floods
		Lack of social safety net		

Source: NIDM

PAR model helps to understand the *chains of cause and effect,* largely rooted insocial processes, and the progression of vulnerability (left side of the figure) that resultsin unsafe conditions in human settlements and empowers the communities to change their disaster vulnerability by altering theirexternal, social, and constructed world.PAR model provides amacro perspective on the social and natural forces that create disasters, but has a limited utility for micro scale analyses, for instancea household as a the center of an analysis. For such analysis, the CARE HouseholdModelis a useful alternative.

b. **CARE Model** is developed by a nongovernmental organization – CARE, involved in humanitarian relief and developmental issues. This model differs from PAR model as it emphasizes at the household level (as embedded within larger scales) and constructed to view disasters as one of many external factors (shocks and stresses) within the context and thus helps to "to identify constraints to family and community livelihood security and design grassroots programs to overcome them." However, this model also adopts the notion of cause and effect to understand the vulnerability and resilience capacity of people to cope with hazard. Thus, the model could be very useful tool in planning the Community Based Disaster Management.

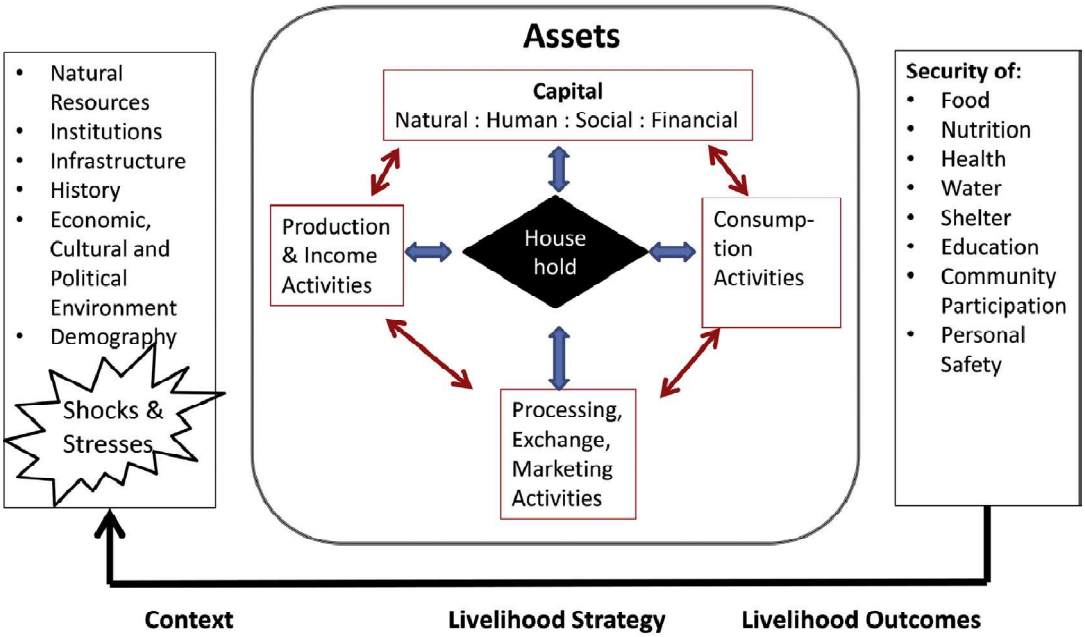


Fig 4.4: Care Model (Source: Lindenburg M., 2002)

III. Risk Management Models

a. **Linear Risk Management Model** Risk management is the process of making informed decisions in an integrated and systematic way. Typically, a risk management strategy consists of identifying the risk, and treating the same in a top-down approach. Such a system of linear decision making model works well when uncertainties are small, hazards and vulnerabilities are well understood and subject to known and available controls and prerequisites for this model are (Tarrant 2002);
    - Support from senior management is critical
    - Developing a risk management process across the whole organization is vital
    - Risk management is a core element of good management practice
    - Risk management needs to have a holistic approach
    - Risk management helps break down silos and divisions in organisations and results in better understanding of objectives

However, in of their top-down approachand deterministic nature, these models are inadequate to deal with complex, chaotic, and unpredictable nature of disasters and hence are phased out gradually and alternativeapproaches that incorporate aspects such as precautionary principle, social discourse, bottom-up strategies became more useful.

Fig 4.5: Steps in Linear Management Model (source: Tarrant 2002)

b. Incident Command System (ICS): This model was developed in 1970 in USA as strategy to deal with massive wild fires in California and was an attempt to overcome the problems such as;

- non-standard terminology among responding agencies,
- lack of capability to expand and contract as required by the situation,
- nonstandard and nonintegrated communications,
- lack of consolidated action plans, and
- lack of designated facilities

ICS is model of a command and control approach, a modular system wherein the decision making was devolved to local levels and activation is limited to only those elements that are neededto deal with crisis.

- At the top of the strategic level is Incident Commander and the General Staff, composed of an Information Officer, a Safety Officer and a Liaison Officer. Section Chiefs may be assigned for the areas of Planning, Logistics, Finance, and Operations.
- Following the strategic level is Branch Directors and Supervisors, which is responsible for meeting operational objectives.
- Unit leaders with the responsibility of executing the specific tasks comprise the Task Level.

Government of India has adopted this model for disaster management and ICS can be found at central, state and at district levels.

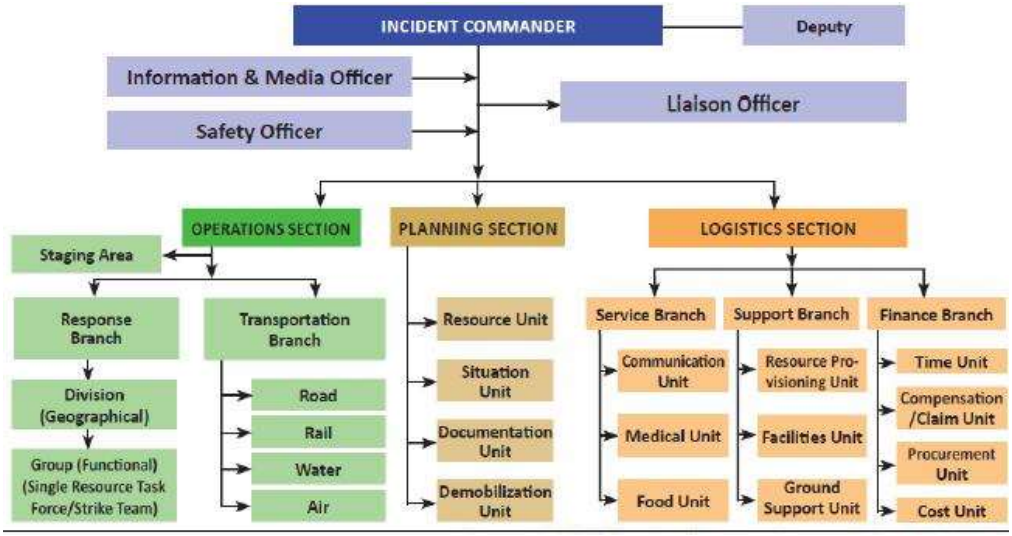


Fig 4.6: Incidence Command System (Source: NDMA 2010)

c. **Catastrophe (CAT) Models**: Growing demand from the insurance companies have led to the development of these models and main purpose of these CAT Models is to estimate the amount of insured damage that would occur due to a catastrophic event such as a severe cyclone, flood, or earthquake *(Grossi, P., &Kunreuther, H. 2005)*.. Based on inputs from meteorology, seismology, engineering, and actuarial science, these models take into account of the vulnerability, exposure and economic value (Fig 4.7).

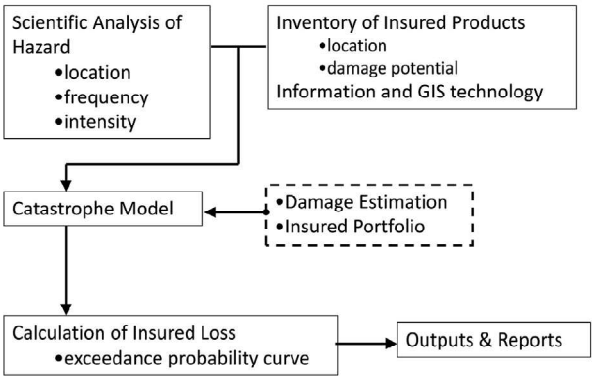


Fig 4.7: Elements of Catastrophe Model (Source: *Grossi, P., &Kunreuther, H. 2005)*

Components of Disaster Relief: Following are typical relief that follows in the aftermath of a disaster

Table 4.3: Components of Disaster Relief

Nature of Details	Details
Relief	immediately after the calamity, lasting from the first 24 hours to about two to three months and catering to immediate shelter, food, water and medical assistance.
Rehabilitation	that looks at more long term inputs of reinstating lost livelihoods, introducing new economic opportunities and improving land and water management processes so as to reduce people's vulnerability and enhance capacities to handle future

	calamities
Reconstruction	following relief and extending to a period of approximately two years, aimed at rebuilding the basic physical infrastructure and shelter to enable people to begin afresh; and,
Readiness,	a response which should ideally have been a proactive measure, is to enhance preparedness in identified vulnerable regions by introducing mechanisms and methods of construction that mitigate impacts of future disasters.

4.2.4Vulnerability and Risk Assessment

As we have learned in previous units, we can broadly define the vulnerability as "a set of conditions and processes resulting from physical, social, economical and environmental factors, which increase the susceptibility of a community to the impact of hazards'. In a society, the vulnerability varies among the different groups, for instance, the pandemic Covid – it was observed that physiologically, aged people with other health problems were more susceptible, economically, it was lower income group that more effected. Thus the vulnerability varies among the effected population. Based upon the vulnerability, appropriate measures can be undertaken to reduce the vulnerability and hence, the vulnerability assessment could be very useful tool in disaster management. The vaiables for vulnerability assessment should be representative of physical, economical and social factors.

Table 4.4: Vulnerability Assessment

	Physical Variables	**Economical Variables**	**Social Variables**	**Ecological Variables**
Variables	Nature of Dwelling, - Type of roof, wall, floor, Location of dwelling – prone to floods, landslides, gusty winds population density levels, remoteness of a settlement, the site, design and materials used for critical infrastructure etc	Income, financial accessibility of individuals and communities, debt and the degree of access to credit, loans and insurance	levels of literacy, access to basic human rights, governance, social equity, gender issues, public health, population density, livelihood activities, traditional values, legal system, traditional knowledge, social networking of relatives and friends, political system customs and ideological beliefs and overall collective organizational systems4	Extent of natural resource depletion, the state of resource degradation, loss of resilience of the ecological systems, loss of biodiversity, exposure to toxic and hazardous pollutants.
Method of Assessment	calculating risks faced by the megacities due to	Participatory Vulnerability Analysis (PVA),		Forward looking assessment – risk based

	the natural hazards. A combination of parameters are used to assess structural safety, viz.,Physical *vulnerability,* Level of *preparedness / safeguards,* C*onstruction quality and building density*	developed by ActionAid, involves communities, local authorities and other stakeholders in an in-depth examination of the factors which make them vulnerable to hazards. PVA helps in breaking down the complexity of vulnerability into manageable components by involving communities. .		Estimate hazard, vulnerability, then combine with risk, combine with climate. Backward looking assessment – impact based Use past damages as manifestations of past risk, then update to current risk Data on past events, information on changes in hazard `and vulnerability.

Risk Assessment

As mentioned in previous sections, Risk is the probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environmental damaged) resulting from interactions between natural or human induced hazards, and vulnerable / capable conditions. Conventionally risk is expressed by the equation (Risk = Hazards x Vulnerability / capacity). Risk assessment is a process to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability / capacity that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. Every risk assessment depends on quantitative and qualitative information as well as an understanding of risk, its physical, social, economic, and environmental factors and consequences. In simple words, two elements essential for assessment of risk, viz., the probability of occurrence for a given threat – **hazard**; and the degree of susceptibility of the element exposed to that source – **vulnerability.**

Risk Assessment serves as the first step for any other disaster reduction measure. By the systematic use of available information about likelihood of disaster incidences and the magnitude of their possible consequences helps in risk assessment. It constitutes both quantitative and qualitative information, along with an understanding of its physical, social, economic, and environmental factors and consequences. The process of risk assessment if carried out various stages, viz,

- Identifying the nature, location, intensity and probability of a threat
- Determining the existence and degree of vulnerabilities and exposure to the threat
- Identifying the capacities and resources available
- Determining acceptable levels of risk

Several agencies have developed different models for risk assessment and a brief description of a few such models

The Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) is a decision support tool that is based on the Environmental Impact Assessment (EIA) methodology and the Sustainable Livelihoods Framework (SLF). Community-level projects influence climate vulnerability and adaptive capacity. CRiSTAL aims to provide a logical, user-friendly process to help the users better understand the links between climate-related risks, people's livelihoods, and project activities. By focusing on community-level projects, CRiSTAL promotes the development of adaptation strategies based on local conditions, strengths and needs. http://www.cristaltool.org

Risk analysis (RA) is used here to refer to a method of determining the quantitative or qualitative degree of risk. The term "risk analysis" consists of the underlying concept of **"participative risk analysis"** (P-RA), whereby the affected target population are involved in the various stages of risk analysis, and adopt the DRM as their own. **Risk analysis (RA)** combines hazard analysis and vulnerability analysis, together with analysis of protective capabilities (as described in figure). In this methodology, the analysis of self-protection capabilities is treated as part of vulnerability analysis. The risk analysis methodology is used to enhance the importance and priority of disaster prevention and preparedness and make it more effective, as a way of reducing damage and losses from extreme natural disasters (droughts, floods, landslides, earthquake), thereby reducing the need for emergency aid. This model is developed by GTZ. www.gtz.de/de/dokumente/en-riskanalysis-chs1-6.pdf

Participatory Assessment of Disaster Risk (PADR) Method developed based on the Crunch and Release models. PADR uses five categories of analysis. These five categories relate to different types of assets viz. Economic, Natural, Constructed, Individual and Social. The method based on the premise that an asset is something that can be used for improving well-being. By analysing these categories for risk assessment one can ensure that all aspects of vulnerability and capacity are assessed through appropriate risk reduction measures. (Source Paul Venton and Bob Hansford, Reducing risk of disaster in our communities)

To Do Activity
• Explain the Incident Command System • Mention the major aspects of vulnerability and risk assessment • Describe the essential features of Indian disaster management

4.4Disaster Preparedness Policies

About sixty percent of landmass in India is prone to earthquakes of various intensities, over – 40 million hectares is prone to floods, about eight percent of the total area is prone to cyclones and 68 percent of area is susceptible to drought. In view of extensive risk from natural disasters, Government of India has enacted the National Disaster Management Act in 2005. The act defines "Disaster means catastrophe, mishap, calamity or grave occurrence in any area, arising from nature or man-made causes, or by accident or negligence which result in substantial loss of life, of human suffering or damage to, and destruction of property, or damage to, or degradation of environment, and is of such nature or magnitude as to be beyond the coping capacity of the community of affected areas." Further, the Act defines Disaster Management as, a continuous cycle and integrated process of planning, organizing, coordinating and implementing, coordinating and implementing measures which are necessary or expedient for

- Prevention of danger or threat of any disaster;
- Mitigation or reduction of risk of any disaster or its severity or consequences;
- Capacity-building;

- Preparedness to deal with any disaster;
- Prompt response to any threatening disaster situation or disaster;
- Assessing the severity or magnitude of effects of any disaster;
- Evacuation, rescue and relief;
- Rehabilitation and Reconstruction. Disaster Management Amendment Bill, 2006 aims at broadening the meaning of Disaster in Disaster Management Act.

The Act provides for three tier mechanism for Disaster Management in the country, viz.,

- **National Disaster Management Authority:** Its chairperson is the Prime Minister. Not more than nine other members can be there. Vice Chairpersons is appointed from amongst members by the Chairperson. Executive Committee is chaired by the Secretary of the Ministry entrusted with the work of the Disaster Management.
- **State Disaster Management Authority:** Its Chairperson is the Chief Minister of the concerned State. Other members not exceeding eight are there. And in addition, Chairperson of the State Executive Committee (who is Chief Secretary) is also included. Vice Chairperson is appointed by Chairpersons from amongst members. Chairperson of the State Executive Committee is the Chief Executive Officer. State Executive Committee is chaired by the State Chief Secretary.
- **District Disaster Management Authority**: Under the leadership of District Commissioner/ District Collector, this authority governs the disaster management at district level.

In addition, the Act has facilitated the following

- **The Ministry of Home Affairs (MHA)** in the Central Government has the overall responsibility for disaster management in the country.
- **National Disaster Response Fund:** To be constituted by the Central Government for emergency response, relief and rehabilitation.
- **National Disaster Management Fund:** To be constituted by the Central Government for the projects exclusively of mitigation.
- **The National Institute of Disaster Management (NIDM)** has the mandate for human resource development and capacity building for disaster management within the broad policies and guidelines laid down by the NDMA.

4.3.1 National Policy on Disaster Management adopted in 2009, is a comprehensive policy document lays down policies on every aspect of holistic management of disasters in the country. It aims to minimize the loss of life, livelihoods and property with a vision to build a safe &disaster resilient India by developing a holistic, proactive, integrated, Multi-disaster oriented and technology driven strategy. This Policy is intended to promote a culture of prevention, preparedness and resilience at all levels through knowledge, innovation and education. It encourages mitigation measures based on environmental sustainability.It seeks to mainstream disaster management into the developmental planning process and provides for Institutional and Financial arrangements at national, State, and District-levels for Disaster Prevention, Mitigation, Preparedness and Response as it ensures adequate budgeting for disaster mitigation activities in all Ministries and Departments.

4.4.2 Pubic Awareness and Warning Traditionally, “alerts” have been used to indicate that something significant has happened or may happen, while “warnings” typically follow alerts and provide more detail information indicating what protective action should be taken. The purpose of alerts and warnings is to provide the necessary information to warn the public and effect the necessary actions that will lead to their safety and to deliver the messages to populations at risk of imminent threats with the goal of maximizing the probability that people take protective actions and minimize the delay in taking those

actions.

Disasters result in destruction of lives and livelihoods, but the extent of the damage caused by a hazard is related not just to its severity, but also to the capacity of people living in disaster-prone areas to prepare. Developing early warning systems can provide timely and effective information to help people and communities to respond when a disaster strikes. Early warning systems are combinations of tools and processes embedded within and composed of four elements, a) knowledge of the risk, b) a technical monitoring and warning service, c) dissemination of meaningful warnings to at-risk people, and d) public awareness and preparedness to act.

But early warning systems do not exist in every part of the world. A quarter of the countries assessed in the 2011 Global Assessment Report for Disaster Risk Reduction reported that communities did not receive any timely warnings for impending hazards, existing ones are still in need of improvement. Discussions on how to improve effectiveness can be informed by critical analyses to determine what early warning can realistically achieve, and what is outside its limitations .

However, improving the effectiveness of early warning systems does not, in itself, lead to reduced risk for disaster-prone communities — early warning does little good unless it is followed by (early) action. The manner the warning has been disseminated, presented to the intended user and the user's capacity to actually receive, understand, believe and act upon the information forms most critical components. Thus, an effective early warning should aim to enhance:

- User awareness about the early warning system and means to access the same,
- Information to be presented in plain, concise language and the user must be able to understand the meaning of the warning,
- User faith on the service as to believe the information received by them – its credibility, reliability, accuracy and timeliness.

All these can be achieved by a well-organised and coordinated public education and awareness programme with the objectives as follows:

- To increase weather literacy and interest in meteorological topics in general, and also ensure that warnings and forecasts provided by the NMHS are understood by the intended users;
- To build up a high level of awareness of hazards and preparedness and how to deal with them;
- To strengthen relationships between members of the hazards community to enable emergency management authorities to make well-informed decisions, and
- to minimise the potential for misinterpretation of information and communication of misinformation to the public;
- To provide information to the public on the role of the NMHS, what types of products and services are available and how to obtain them.

The Warning Process for Imminent Events

Public response to an alert or warning message is only one part of an emergency alert and warning cycle. Below is a simplified cycle of what occurs during an alert and warning exercise:

- The event must be detected.
- A decision on whether or not to warn the public must be made.

- The public must receive and subsequently understand the warning.
- The public must have been given options of actions to take or safe places to go.
- The public must choose to take action.

Imminent threats include both natural and humanmade disasters, like severe weatherconditions, terrorist attacks, active shooters, or biological/chemical threats.

The Process of Milling

Milling is the process of seeking information from others regarding alertand warning messages. Individuals milling go through the following steps uponreceiving an alert or warning:

- Understanding1—This type of understanding refers not to the correct interpretation of what is heard, but to the personal attachment of meaning to the message. The meaning of a message can vary between different people.
- Believing—People determine whether or not to believe that a warning is real.
- Personalizing3—Even if a person understands and believes a warning, they will not act if they do not believe that they, their families, or their group are targets of the warning (also referred to as risk personalization).
- Deciding—People will decide what (if anything) to do about the risk.
- Deciding is recognized as part of the pre-response sense-making process, but it has rarely been explicitly studied as a variable in and of itself.
- • Searching and confirming—Searching for additional and confirming information is a basic post-warning receipt but pre-protective action taking behavior.

Source: NAS 2018

Need for public Awareness The gap between warning and heeding warnings are still not effectively communicated, and not sufficiently acted upon, even as agencies in developed and developing countries are now more aware of the nature, frequency, locations and intensity of various hazard types, and have advanced technical capabilities for monitoring such as climate models and remote sensing. For instance, with current day technology, incidences of lighening can be predicted with reasonable accuracy and that information can be communicated to the community through mobiles in vulnerable areas with about ten minutes in advance of actual happenings. Still, the lightening causes the highest number of deaths among the natural disasters in every year.Probable reasons for failing to act on disaster warnings could be the inherent uncertainty in scientific information. Scientific jargons, language and format that generally used in warnings are not easily understood by the local communities. Risk prioritizing is another reasons. For instance, for a shepherd, the herd is more important that the warning of possible lightening in that area as the herd forms livelihood and therefore, he tend to ignore the warning and may stay looking after the herd. False alarms can also undermine public confidence and reduce the significance accorded to the warnings.

4.4.1 Disaster Preparedness Initiatives

- **National Emergency Response Force** It is a special force trained and provided with required rescue and communication equipment for immediate rescue operations in case of any disaster takes place. They are placed in various parts of the country that enables them to reach the place of disaster quickly.
- **Fire Services** In order to further strengthen the capacity for immediate response to help the effected community in case of disasters, the fire services are upgraded in phased manner into multi-hazard response units (as is the practice in other countries).
- **Regional Response Centers** Fourteen Regional Response Centres have been formed and each one is well stocked with a cache of essential search and rescue equipments so that they can respond to any disaster in the neighbouring States immediately.

- **Emergency Operations Centres**The States are being assisted to set up and/or upgrading the control rooms/emergency operations centres at the state and district level. Assistance for this is being given under the GOI – UNDP project in the States covered by the project.
- **Communication System** The communication network between the national and the state EOCs and the site of the emergency/crises is currently based on the DOT network and it is proposed to put multi-mode and multichannel communication systems in its place so to retain the connectivity. ISRO will be making available alternate satellite communication units to connect with State EOCs and mobile units which can be transported to the site of a disaster.
- **India Disaster Resource Network (IDRN)** One major step towards strengthening of our response system is launch of IDRN, a web based inventory of all specialist equipment required for emergency/disaster response. It enabled to mobilize the required resource for response in the shortest possible time.
- **Incident Command System** In order to professionalize the response, the Incident Command System has been adopted.It provides for specialist Incident Command Teams with an Incident Commander and officers trained in different aspects of Incident Management –logistics, operations, planning, media management etc.
- **Public Education and Training** Focus of a disaster preparedness is to anticipate the disaster and its intensity and requirements that could be needed in post-disaster phase. Most importantly, the community should be aware about the course of action to be followed in case of disaster. Hence, the community education is an essential part of a disaster preparedness and such programmes can take many forms, such as:
    - Public education in schools for children and young adults, emphasizing what actions should be taken in case of a disaster (for example, earthquake tremors);
    - Special training courses, designed for an adult population either specifically or as an extra dimension of on-going programmes such as Preventive Health Care or Maternal and Child Health programmes;
    - Extension programmes, in which community and village-based extension workers are instructed to provide relevant information and trained for the tasks they should undertake during the event;
    - Though the direct instruction has better impact, mass media, can also be effectively used, if sensitively designed and presented, Mass media could provide a useful supplement to the overall educational process.

To Do Activity
• Explain the Preparedness Initiatives by Government of India • Role of Community in terms of preparedness • Describe the Institutional arrangement for disaster risk reduction

4.5 Rehabilitation Measures and Long Term Reconstruction

As we have seen in earlier sections that disaster management cycle can broadly be divided into recovery, preparedness and development phases. Thus recovery phase, between response and long term development has influence on them and has two constituents, viz., rehabilitation and reconstruction. Though the distinction between two is not a watertight distinction, rehabilitation refers to the restoration of local services and ensuring the resumption of basic services in disaster effected region, and is a systematic effort to return to pre-disaster status, while the reconstruction represents the long term assistance for development. It has the future needs and demands and also aims to reduce the future disaster risk. Different phases of response are;

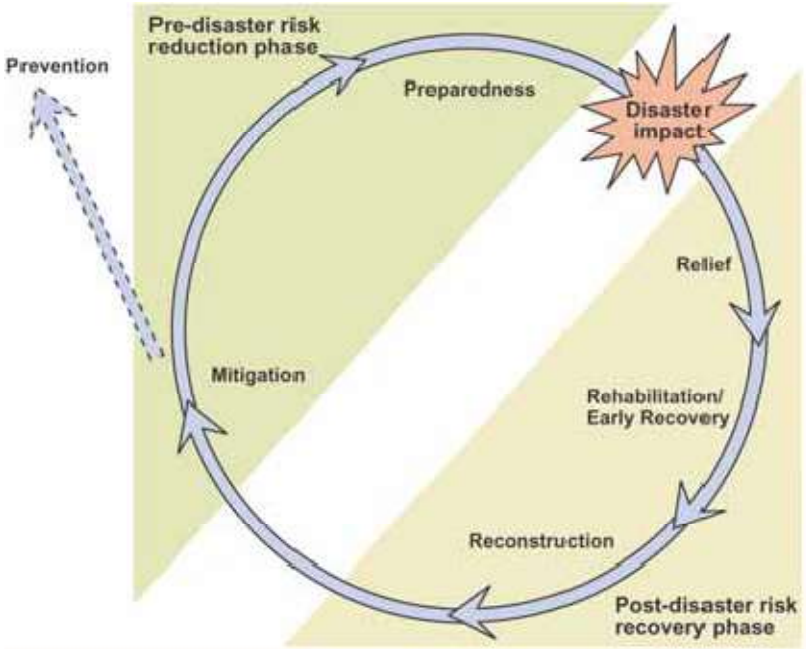
- **Emergency or humanitarian relief/early recovery phase** – the immediate post recovery, which can last days, weeks or months depending on the nature of the disaster and local conditions.
- **Transitional phase** – with the recovery of social institutions, the economy and the main infrastructure, transition to the longer-term recovery and reconstruction process can be implemented. If effective planning for longer-term recovery is a part of the early recovery, then the transition should be short, smooth and imperceptible.
- **Reconstruction, medium-term and long-term recovery** – normally anything from six months to many years

4.5.1 Rehabilitation Every disaster, depending on its intensity, inflicts the damage at the place of its incidence and leave a trail of destruction. To provide some relief and to help the effected community to restart their life and get back to normalcy, immediately after the disaster event, government and non-governmental organizations provide some emergency support to the effected community in the form of essential items etc., and the community has to restart its life and we can identify the requirement of three types of rehabilitation,

- **Physical Rehabilitation** is a very important facet of rehabilitation as most of physical structures might have been damaged by disasters and most of the physical infrastructure such as houses, buildings, roads, bridges, water supply network, electricity,railway lines may need immediate attention. On the other hand, restoration of canal, agricultural rehabilitation, watershed management etc require long term strategies. All these activities involveexpenditure and to the extent possible, in every construction, future disaster risk reduction needs to be incorporated.

- **Social Rehabilitation**: Disasters of severe nature known to destroy entire villages and in due course of time, physical rehabilitation process helps to reconstruct the villages. However, during the process, one of the important component - social rehabilitation tend to get ignored. Disasters can render some groups such as the elderly, orphans, singleparents with young children, etc., much more vulnerable to disaster aftermath due to lackof adequate support. In the post-disaster phase, family support systems can break downdue to physical and mental trauma resulting from losses of life and property, physicaldislocation, and migration of some members of disaster affected communities and these groups would need special social support to survive the impact ofdisaster. A realistic recovery plan has to take note of thissocial dimension of the disaster-affected area.

- **Psychological Rehabilitation**The psychological trauma of losing relatives and friends, and the scars of overall shockof the disaster event take very long time to heal and hence, the importance of social welfare and psychological support programmes be considered immediately after a disaster event sothat they could be made a vital part of recovery programmes. No recovery plan can be successful if it does not take cognizance of the psycho-cultural milieu of the affected site.



4.8: Relief in the Cycle of Disaster Management Cycle
Source: *Max Lock Centre, figure 4 Main Report, after RICS 2006, p1.*

4.5.2 Long Term Reconstruction

Disasters leave a trail of destruction and their adverse impacts set development gains back by decades. Further, they also result in increase in vulnerability several folds. Most of the relief efforts are focused on meeting the most immediate needs in terms of medical treatment, food, shelter and basic services, and is inadequately concerned with longer-term recovery issues. Humanitarian relief is often very effective, but seldom leads smoothly to rapid, effective and productive medium-term recovery and long-term reconstruction. Hence, the need arises for a post disaster response strategy to rebuild lives and livelihoods in a manner that paves a way for long term sustainable development. Otherwise, disasters may inhibit large sections of the effected society to come back even to the base levels even. Hence, it is critical that the requirements of medium and long-term recovery are planned for and co-ordinated at an early stage.

Table 4.5: Phases of Disaster Response

Emergency or humanitarian relief/early recovery phase	immediate post recovery, which can last days, weeks or months depending on the nature of the disaster and local conditions.
Transitional phase	with the recovery of social institutions, the economy and the main infrastructure, transition to the longer-term recovery and reconstruction process can be implemented. If effective planning for longer-term recovery is a part of the early recovery, then the transition should be short, smooth and imperceptible.
Reconstruction, medium-term and long-term recovery	normally anything from six months to many years

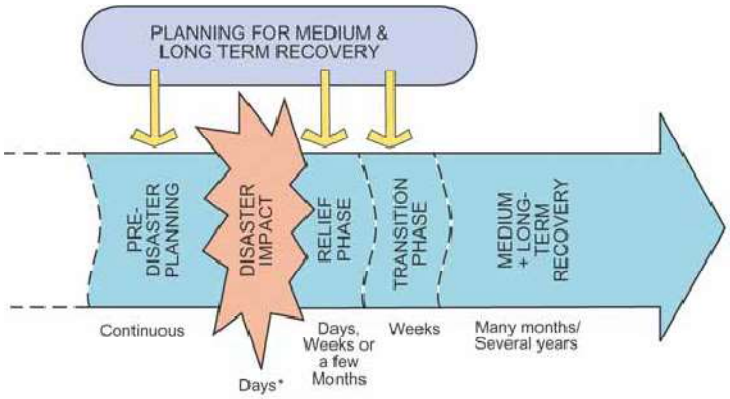


Fig 4.9: Strategic Location of Long Term Planning
Source: *Max Lock Centre, figure 4 Main Report, after RICS 2006, p1.*

In order to achieve the best possible outcomes, recovery plan should consider the following priorities. Viz., ,

- Provision of emergency relief to be operationalised by the way of mobilising human and material resources on a war footing, comprising food security, construction oftemporary shelters andother basic needs
- Rehabilitation of all the displaced people, restoration of basic and alternative meansof livelihood along with community-based infrastructure and institutions; and
- Initiation of long-term development interventions, which would lead to sustainable community-based actions (Medury and Dhameja, 2005).
- Few points that shall be borne in mind for an effective rehabilitation program are;
- **Treating Communities as Heterogeneous**: No community is homogenous and every rehabilitation plan should consider this aspect. To the extent possible, the plan should reflect heterogeneity of effected community. In addition, the requirements of effected household are also vary and due consideration shall be given in recovery plan
- **Balancing Economic, Social and Psychological Needs** also vary from one group to the other within the affected community and these needs have to be carefully considered.
- **Focus on minimising the adverse effects of future disasters** forms the focus for achieving the efficacy of various objectives of rehabilitation projects. The success of these projects depends upon the way they are managed and the way the affected population perceives the various rehabilitation programmes as appropriate means of meeting their requirements.
- **Promoting Systematic Damage Assessment** Damage assessment is a precondition for effective disaster management the need for a methodical damage assessment so that the strategies of livelihood creation and infrastructure development can be incorporated in the recovery plan. The assessment could take recourse to sample surveys (simple random, systematic, cluster, stratified), and make use of traditional means as well as modern technology damages.
- **Risk management** is another dimension and is now the focus of several frameworks and there are three different stages of managing risks, a) perception of risk is very important at all levels, that is, the local residents, the NGOs, the donors, should all have adequate perception of the risk, b) Risk assessment is more of a technical word and is rather the responsibility of the academicians or professionals to quantify the risk in that area or community, which aids in mapping its vulnerability. and c) mitigation of risks focuses on policy level decision-making, which is a collective effort.

- **Monitoring and Evaluation**The recovery plan must be clear, structured, objective, accessible, accountable and responsive. Continuous monitoring and evaluation (M&E) could ensure transparent, efficient and effective plans. M&E exercise could follow the SMART (Specific, Measurable, Attainable, Relevant and Time-bound) tool of indicators, which have to be set at the planning for recovery stage itself.
- **Ensuring Financial Recovery** One of the most important components of rehabilitation and reconstruction is that of infrastructure development, which largely depends on financial support. Governments has made provision for such activities in the form of State Disaster Mitigation Fund. Schemes such as Swarnajayanti Gram SwarozgarYojna, National Agricultural Insurance, Seed Crop Insurance, Kisan Credit Card, etc., may also be explored for the plan execution.
- **Building Resilient Communities**A participatory disaster recovery programme that involves the local people, civil society organisations and grass roots agencies at decision-making and implementation stages would go a long way in shaping a more humane and feasible disaster rehabilitation programme. A good recovery plan must aim at building resilient communities. This can be ensured through four major strategies (i) Community Participation, (ii) Education and Training, (iii) Stress Management, and (iv) Positive Role of the Media.

To Do Activity
• Describe the importance of post disaster measures • Explain different aspects of Rehabilitation • Explain the need to focus on long term reconstruction

Further Reading

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Chapter **5: Community Adaptation through Resilience Building**

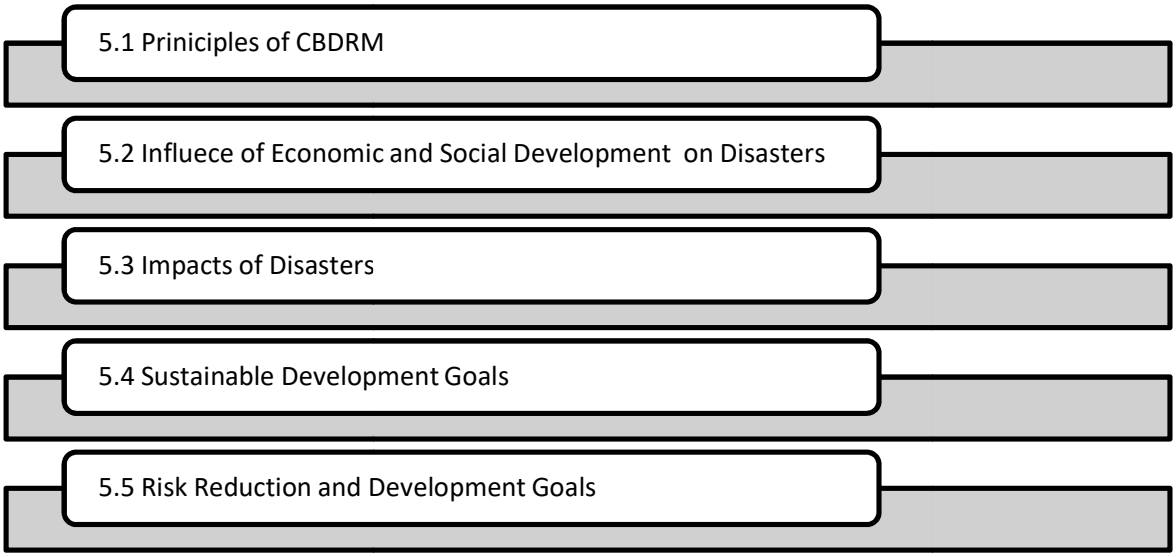
5.0 Introduction to the Unit

Increased incidences of disasters and associated loss of life and economies have drawn the attention of global community towards systematic disaster management. Since then, there has been significant development of global understanding about the disasters, preparedness efforts and also post-disaster rescue and relief measures. From these lessons, various frameworks have been developed for effective management disasters. International experience has showed that, disasters are posing increased threat to the development gains, poverty reduction, and achievement of the Sustainable Development Goals (SDGs) and community being the first to respond to disasters, it is their preparedness and their response to early warnings that determines the impact of disaster. Hence, the Investments in community- based preparedness and early warning systems can save lives, protect property, and reduce economic losses. This understanding has led to reorientation of disaster risk reduction processes into community based disaster risk reduction management (CBDRM). This chapter introduces various aspects of CBDRM.

Objectives

This chapter presents various concepts, viz.,

- community based disaster risk mitigation,
- relationship between the economic development and disaster,
- Impact of disaster on Social development,
- difference in the impact of disasters in development and developed countries, and
- rehabilitation and rural resilience aspects.



5.1 Community Resilience

—**Where communities are equipped and prepared, disasters clearly have much lesser impact, especially in terms of the loss of lives**‖. (**UNISDR**)

As previous chapters have indicated, hazards are natural and with proper understanding of risk, we can reduce the risk to our societies and make them risk resilient, but we cannot make them risk proof. The idea of "climate proofing" development is only a utopian concept. At the most, we can systematically identify and reduce the vulnerabilities to the various hazards.In other words, any society may be

affected by disaster, not essentially the natural, it could be man-made disaster even. We have learnt in previous chapters that there have been elaborate institutional mechanism and also detailed disaster management plans prepared by concerned government departments and other concerned institutions in civil society. However, when any disaster strikes, it is the community in that place that will be effectedforemost and bear the destruction. It is the state of preparedness of that community which will determine the damages inflicted by the disaster. It will be the resilience of community that plays a significant role on the duration of the adverse impacts of the disaster. Thus, we can define the Resilience as the ability of vulnerable individual communities, organisation or countries to anticipate, reduce the impact of or cope with and recover without compromising their long term prospects (IFRC, 2015). Typical resilient community is a community that can absorb, respond, adapt and transform wherever it is necessary. Traditional Indian society, enriched by traditional knowledge system is best example of resilient community. In every agro-climatic regions, we can find wide array of practices and customs which create a buffer for the community absorb the shock of natural disasters. For instance, annual practice of desiliting lakes as community practice in semiarid regions of India. By desilting the tank, the village community is making itself prepared for possible drought conditions. However, with the advent of disruptive technologies like borewell, the social fabric was broken and tanks were mismanaged. On the flip side, within a few decades of introduction of borewell technology, rampant extraction has led to alarming rate of decline in groundwater table level and several borewells failed. This has forced the government to rejuvenate the tanks . In post disaster phase, respective organizations will step in to help the community, but there will be a time gap between the disaster and arrival of external help. As first respondent, the community can play a very significant role in every stage. Further, the interactional experience has showed that higher the level of community resilience, lower would be the negative impacts of the disasters (NIDM 2020). Community resilience can be enhanced through community Based Disaster Risk Reduction (CBDRR).

5.1.1 Community Based Disaster Risk Reduction (CBDRR)

CBDRR is a process that initiates sequential stages that can be operationalized to reduce disaster risk at the community level, viz., Hazard,Vulnerability, Capacity and Risk assessment, risk reduction planning, early warning systems, post disaster relief and participatory monitoring and evaluation. CBDRR by its very nature demands a decentralized bottoms-up approach with intensive, micro interventions at the local panchayat, ward or village level. This is to develop knowledge,confidence, awareness, partnership and ownership for planning and rolling out local disaster management plans encompassing all levels of disaster management continuum (NIDM2020). Community involvement at every level of disaster management has several advantages, viz.,

- Disaster risk reduction measures are most successful when they involve the direct participation of the people who are most likely to be exposed to hazards. Community is the first to respond to a disaster. Investments in community- based preparedness and early warning systems have proved to save lives, protect property, and reduce economic losses.
- Failure to understand the risk behavior and culture of local communities can lead to badly designed preparedness measures including early warning systems .
- The involvement of local people promotes self-reliance and ensures that emergency management plans meet local needs and circumstances. Indigenous knowledge, wisdom and innovation with respect to hazards and mitigation.
- Disaster relief and recovery responses that do not directly involvethe affected communities tend to be inappropriate and unsustainable forms of assistance.
- Organized communities are in a better postion to demand downward accountability, and that a community-level focus facilitates the identification of vulnerable groups.

India is prone to various disasters. On account of its huge diversity, it is not uncommon to suffer from floods in one part of the country while the other part is undergoing through severe drought conditions as well. The factors like geo-climatic conditions, topographic features, environmental degradation, population growth, urbanisation, industrialization, etc enhance our vulnerability to the disasters and subsequent loss of life and also the economic losses. Climate change is expected to increase both intensity and frequency of the natural disasters, in addition to give rise to new vulnerabilities with differential spatial and socio-economic impacts on communities. Since community is the first responder in every incidence of disaster, efforts have been made to encourage community level initiatives for disaster preparedness and community involvement in mitigation measures through various policy documents. These measures are intended to empower communities in terms of planning and response to disasterseffectively, by means of awareness, skill up-gradation, training and capacity building on rescue and relief services, early warning systems and development of community based Disaster Management Plan as detailed below.

The Disaster Management Act 2005, provided for formation of District Disaster Management Authority (DDMA) at the district level.

- Section 22(2)(i) of the Act promote general education, awareness and community training in regard to various disaster to which States/UTs are vulnerable. It also emphasis on taking suitable measures to prevent, mitigate and respond to disaster.
- Section 30(2)(xiii) facilitate community training and awareness programmes for prevention of disaster or mitigation with support of local authorities, governmental and non-governmental oganisations. It encourages participation of non- governmental organizations and voluntary social-welfare institutions working at the grassroots level in the district for disaster management

The **National Policy on Disaster Management 2009 (NPDM)** lays special emphasis on community based disaster preparedness (Para 5.3.1 and 5.3.2 of Chapter 5 on Disaster Prevention, Mitigation and Preparedness).The policy recognizes community as the bedrock of the process of disaster response. It also gives emphasize on training, simulations and mock drills of vulnerable sections. It also promotes stakeholder participation including encouragement to Non-Governmental Organizations for community empowerment.

- On response matters, the community has been given due recognition in all the relief and response processes including animal care and relief camp management. In the reconstruction phase, the policy outlines the concept of the owner driven reconstruction. It also prioritizes training for developing community based DM systems for their specific needs in view of the regional diversities and multi-hazard vulnerabilities.

The 73rdand 74thConstitutional Amendments –"Institutions of self – government" have decentralized and devolved the financial and administrative powers from the district downwards right up to the Gram Sabha level in rural context and ward level in the urban context. The Amendments extend the devolution to the disaster management as well.

- The community based organizations shall work in overall partnership with local authorities in States/UTs. The elected representatives of these local bodies are the key stakeholders through whom effective participation and ownership by local communities can be achieved in CBDRR.

The Framework of CBDRR: The following are non-negotiable and basic principles of CBDRR (Table 5.1);

- **Multi stakeholders" participation:** Community, comprising all of its social classes and strata forms the nucleus of the CBDRR process. Participation of the community is the key for any DRR intervention along with the participation of other stakeholders such as

NGOs/ CBOs/ community leaders, traders, line departments, elected representatives, banks, etc. All these stakeholders can be grouped into different spheres, viz. Assessment, Planning, Capacity Building, and implementation

- **Participatory Approach with community as lead:** Every individual participates and share his or her perception about the gaps and needs for resilienceand voluntary action for ―risk aware disaster and development planning‖ through the coordination of various stakeholders from community to PRIs. This results into formation of formal community based institutions and informal groups which help individuals to express their concerns and needs for development and risk reduction.
- **Involvement of informed facilitators:** As several stakeholders work together, role of an informed facilitator helps to achieve the larger goal and enables to prepare for potential risks and learn from good global, regional and other local practices.
- **Time and Resource budgeting:** CBDRR processes are not just steps but a process of change (attitude, behavioral and capacity) for enhancing resilience of the community and it requires long term commitment by the community as well as facilitators as its impact is not visible in economic terms gains.
- **Forum for convergence:** There are several government schemes and programs extremely crucial in the context of community disaster management such as poverty alleviation, school education and nutrition, maternal and child health, drinking water and sanitation programs etc. and convergence of these programs can lead to higher levels of resilience.
- **Inclusive Approach:** is essential for the successful CBDRR.

Table 5.1: Basic Principles of CBDRM

- Planning, implementation and management owned by community, led by local champions.
- Interventions start from locally available resources, capacities and partnerships.
- Community considers choices and takes decisions.
- Programmes focus on developing local coping capacities.
- Disaster preparedness approached from a development perspective.
- Sustainability considered as an underlying factor.
- Attention to special vulnerable groups

These principles are translated into implementation strategies for creating the desired impact on the ground (IGNOU Unit 3), viz.,

a) **Public Awareness** is the first step of CBDRM and leads to enabling environments and linkages with resources for fulfilling this demand.Public awareness can be created through community meetings, events, mass communication programmesorganised by non-government organisations, and activity based awareness interventions on the part of the government.
b) **Research and Documentation** Every disaster is unique though the nature of risk is similar. Further, the vulnerability of a community is dynamic and it changes constantly. Thus, every situation demands specific intervention as per sensitivities which need to be periodically studied/ monitored; Understanding of social dynamics is also crucial to understanding threat in each case.
c) **Capacity Building** is process wherein the reserve capacity of the communities is upgraded that gives the community more staying power during disasters. It also helps in lowering the dependence on external assistance, and local communities can increasingly be able to take care

of their recurrent needs. Capacity building helps in better emergency response, in addition, it decreases the vulnerability to future disasters. World Disaster Report (2006) has drawn six policy prescriptions, viz.,

- Systematic assessment of what enables people to cope with, recover from and adapt to risks and adversities, at household and community level, is badly needed.
- Strengthening social capital should be the key objective of disaster interventions, whether in relief, recovery or risk reduction; rather than a by-product.
- People-centered approaches to development provide models that can improve humanitarian aid and disaster risk management.
- New institutional strategies and cross-sectoral coalitions are required to boost the resilience of local livelihoods in the face of multi-dimensional risks.
- Good governance is essential to create the environment, in which the more resilient communities can thrive.
- Scaling up strategies based on the aspirations and capacities of people 'at- risk' remains the greatest challenge.
- Networking

The Process: CBDRR as the name itself indicates is collective effort by the community to help itself from negative impacts of the disasters and is a continuous process with several parallel movements, viz.,

a) Engaging community and enabling creation of volunteers in a reflective exercise so as to fundamentally bring attitudinal shift for proactive and resilient action.
b) Engaging with institutions, government and non-government as well, and developing the appropriate programming framework of such engagement by realizing their own capacities for resilience.
c) Comprehending the developmental processes of government, especially through various government schemes/programmes directly and indirectly related to responding, preventing or mitigating disasters.
d) Identifying vulnerable and risk reduction measures prioritizing by the communities themselves, especially with respect to sensitive sections of population such as women, children and weaker sections who are more often susceptible to the vulnerabilities.
e) Understanding and enlisting livelihood opportunities.
f) Preparing Disaster Risk Reduction Plans and drawing out outcomes by intensive engagement with government and governmental institutions.
g) Implementation of Disaster Risk Reduction plan and documentation of lessons learnt for upgradation of disaster risk reduction plan.

5.2 Indluence of Economic and Social Development on Disasters

Nobel Prize Laureate Prof. AmartyaSen (1981), in his seminal economic history of famines, famously observed: —starvation is the characteristic of some people not *having* enough food to eat. It is not the characteristic of there *being* not enough food to eat, the central emphasis is that the costs associated. Similarly, extending the same logic of Prof. Sen, it is important not only in understanding what happens after a disaster occurs, but rather that the very occurrence of disasters is an economic event. For instance, Super Cyclone in southern Odisha during early 2000s has left a trail of economic devastation and also loss of human life as well. However, the Hud Hud Cyclone that struck Vishakhapatanam has, though caused economic losses, has not resulted in loss of life, indicating the outcome of different set of policies in operation during two different periods. Similarly, with disasters, we can identify two broad approaches, viz., *ex-ante* mitigation and *ex-post* coping with natural disaster shocks. Since, the

declaration of Decade of Disaster Risk Reduction in 1990, there has been a large knowledge base developed on mitigation measures. But implementing these measures would cost resources and therefore it is useful to conduct a careful evaluation of the likely *ex-post* impacts and the probability of disasters occurring and the extent of mitigation measures that could avoid the ex-post damages. Such an evaluation help in decision making in ex-ante mitigation measures. During ex-post analysis, we can identify two categories of damages, viz.,

a) Direct damages - damage to fixed assets and capital, damages to raw materials, mortality and morbidity,

b) Indirect damages, on the other refer to the economic activities - the production of goods and services, that will not take place following the disaster and because of it. These indirect damages may be caused by the direct damages to physical infrastructure, or because reconstruction pulls resources away from production or even the loss of income at the household level.

Various factors influence the extent and intensity of damage. For instance,

- the size the economy of country. Generally, bigger the economies, diversification tend to be higher and it is capable of engineering the inter-sectoral and inter-regional transfers required to mitigate the economic impact of natural disasters.
- Similarly, the geographic location. It is also a critical determinant of the physical vulnerability of certain regions/countries to different types of natural disasters. For instance, the east coast of India is more prone to cyclonic disturbances compared to West coast. The small islands – Andaman and Nicobar islands are vulnerable on both dimensions, i.e., the scale of economy and physical location.
- Even by their size alone, large developed states can more easily absorb shocks from natural disasters.

On the other plane, the impacts of disasters can be examined on the basis of duration of the impacts, short term and long term. However, most of the literature on the impacts of disasters are related to the economy, focus on domestic production (GDP), while other impacts of disasters, for instance, inadequate infrastructure, human development index, are often under-investigated.

5.3Impact of Disasters on Development

- Disasters wipe out the gains of economic development: Catastrophic disasters result in the destruction of a nation's assets, and interrupt production, trade, investment, and other economic engines.
- Larger countries, with a greater geographical spread of economic assets relative to the spatial impact of disasters, are more able to avoid direct loss and minimize downstream, indirect or secondary losses.
- Like the size of a nation's economy, the physical size of the area within the country that is affected by a disaster in proportion to the total size of the country has a strong influence on the setback to development. Small island countries, for instance, experience disasters that impact up to 100% of their land mass. A volcanic eruption on the Pacific island Montserrat in 2001 resulted in damages that made almost three-quarters of the island uninhabitable, and resulted in a reduction in population of 64% (due to migration away from the island).
- A lack of economic diversification, which tends to persist primarily in nations suffering from poverty, can also contribute to pronounced impacts from disaster events that ultimately stall development.

- When disasters affect the few or the primary sources of national income, it is devastating to an economy that has few other sources to draw upon.

5.3.1 Disasters Limit Social Development

- *The loss of social assets due to a disaster or any other event ultimately results in magnification of vulnerabilities.*
- *Disaster events destroy gains in the health, sanitation, drinking water, housing and education sectors that have underpinned social development. For instance, Orissa's Super Cyclone - led to the contamination of drinking water wells and damaged many schools in the impacted area*
- *Indirect impacts in the social sector also contribute to the negative effect on development.*

Table 5.2: Influence of Economic and Social Development on Disasters

Economic development increases disaster risk	**Social development (SD) increases disaster risk**
If the economic growth occurs without regard to hazard profiles, existing mitigation technologies, and ongoing risk reduction programs, an increase in overall disaster risk results. Unsafe and unwise development practices lead to increased and additional risk factors, and oftentimes result in an elimination of existing man-made and natural risk protections. For instance, destruction of mangrove forests for the purpose of tourism.	SD can inadvertently cause increases in disaster risk or vulnerability, In countries resource push cause families to move to urban centers and are forced to settle in poor and informal housing situations. Although their access to social services has increased, their hazard risk has also risen Some 600 million urban dwellers in Africa, Asia, Latin America and the Caribbean live in life- and health-threatening homes and neighborhoods as a result of poor quality housing and unsafe land use practices.
Economic development reduces disaster risk	**Social development reduces disaster risk**
The generation of wealth can raise the basic level of human development. The distribution of wealth, which can enable even the poorest to overcome human vulnerability. The negative externalities of wealth creation (waste, pollution, destruction of environments or human culture) can be controlled By mainstreaming DRR and treatment into existing development practices, it is possible to achieve economic development without generating new risks. In pots- disaster, economic development moves ahead at full speed.In Post-disaster, future vulnerability is addressed in the rebuilding effort.	Social development decreases disaster risk any time that the development practices enable people to improve their living situation. An increase in hazard awareness, risk prevention and response education, and community conformity to practices contribute to individual and collective resilience. Improved health and education, can help reduce vulnerability and can limit human losses in a disaster.

Source : UNDP 2004.

Each disaster has its unique impact and consequences on the affected community. No single formula can be evolved to characterize precisely how these problems will play out.As listed in the table 5.2, state of development also influences the vulnerability and impact of disasters on community. But, every disaster results in exacerbating the causes of poverty in developing countries and some of them are as follows (UNDP 2004);

- Development efforts are stunted, or reversed, for instance, mid-day meal program was affected seriously due to Covid 19 and also the schooling process came to grinding halt.
- Significant portions of GDP would be diverted from developmental programs /allocated to post disaster operations like to financial support for construction of damaged houses, input subsidies for crop damage etc
- Vital infrastructure is damaged or destroyed, including roads, bridges, anganwadies, schools, Primary Health Centers, communications systems, power generation and distribution facilities, drinking watersystems, requiring years to rebuild
- Anganwadies and Schools are damaged or destroyed, or converted into temporary shelters, leaving students without an adequate source of education for months or even years
- Petty and informal businesses are destroyed, resulting in surges in unemployment and decreased economic stability and strength
- Residents are forced or impelled to leave the affected zone, often never to return, as was observed in post lockdown stage of COvid 19
- Desperation and poverty leads to a rapid upsurge in crime and insecurity
- A general feeling of hopelessness afflicts the affected population, leading to increased rates of depression and a lack of motivation to regain independence from outside assistance.

Due to these factors, the impacts vary from country to country depending on their economic status (Table 5.3). Year after year, poor countries succumb to the human impacts of disasters to a greater degree than their rich counterparts. On the contrary, it is the rich countries of the world that feel the higher financial impacts of disasters. In other words, higher the vulnerabilities, greater would be the impacts, for instance, the financial setbacks of disaster events are ruinous for developing countries while their industrialized counterparts would have mechanisms to absorb such shock exist. Economic damages due to disaster in developing countries often result in three types of financial consequences, viz., a) Increased national and private debt, b) Reduced public funding to meet regular budgetary needs and c) Loss of economic activities that support income and tax bases and consequently hampering the process of development. This underlines the importance of adopting a policy that incorporates risk information and two approaches can be adopted, viz.

- ***Prospective Disaster Risk Management****:* integrates hazards and risk management practice into new development that is occurring or that will occur in the future. These activities address and seek to avoid the development of new or increased disaster risks. They focus on addressing disaster risks that may develop in future if disaster risk reduction policies are not put in place. Examples are better land-use planning or disaster-resistant water supply systems (ISDR 2009).

- **Corrective Disaster Risk Management**activities address and seek to remove or reduce disaster risks which are already present and which need to be managed and reduced now. Examples are the retrofitting of critical infrastructure or the relocation of exposed populations or assets.

- ***Compensatory disaster risk management****:* reduces existing risk and addresses the causes of vulnerability. Compensatory policies reduce risk that already exists, while prospective policy is the medium- to long-term solution to breaking the cycle of disasters and stalled development.

Table 5.3: Impact of Disasters on Developing and Developed Countries

Impact of disasters differ on Poor and rich countries. Poor countries are forced to bear the burden of disasters Year after year, and succumb to disasters in a greater degree than rich countries. But, rich countries feel the greatest financial impacts of disasters.

Developing Country: There is a strong correlation between the magnitude of disaster consequence and poverty levels of a country and the positive feedback between poverty and disaster damages keeps on damaging the nation's economy, For instance, recurring floods during the monsoon in several states of India is perianal problem, but the cost of mitigating this risk is extremely high. Hence, the floods keep damaging the significant investments in infrastructure, and would require recurring expenditures to repair the damages. Some disaster incidents may destroy or stall the lives and livelihoods and damage the economy of a region by effecting the pattern of consumption and production of goods and employment avenues and the financial setbacks of disaster events are ruinous

Developing Economy Developed countries also suffer from the disasters. Some developed countries experience more disaster events than their poor counterparts, for instance, Japan is more exposed to natural disasters like Earthquake, Cyclones. However, their economy permits them to mitigate the adverse impacts of exposure. Similarly, the drought – several developed countries are vulnerable to drought, for instance Australia, but they are able to minimize the damages by adoption of appropriate techniques. Developed economies have the mechanisms to absorb financial shocks and resilience of communities help them to come back to pre-disaster level soon.

Structural Resilience: Many vulnerable countries lack disaster-resilient infrastructure covering vital services such as water, sewer, and electricity—even though investment in such infrastructure can have very high returns. Primary reason for lack of resilient infrastructure is the requirement of high up-front capital costs. But, stringent adherence to the building codes, zoning atlas could be an effective answer.

5.2.3 Natural disasters and Corporate Productivity: Creative destructionisachannel through which disasters may enhance corporate productivity that survive the disasters, which is due to the update of their capital stock and the adoption of new technologies. This mechanism is often called creative destruction.There is some evidence for this hypothesis, although mixed. De Mel et al (2011) find that the firms that suffered more damage to their assets because of the devastating tsunami in Sri Lanka in 2004 exhibited smaller profits, sales, and capital stock.[1] Cole et al. (2013) and Tanaka (2015) find that the plants located in the most devastated districts during the 1995 Kobe Earthquake exhibited smaller employment and value-added growth. These findings are inconsistent with creative destruction.

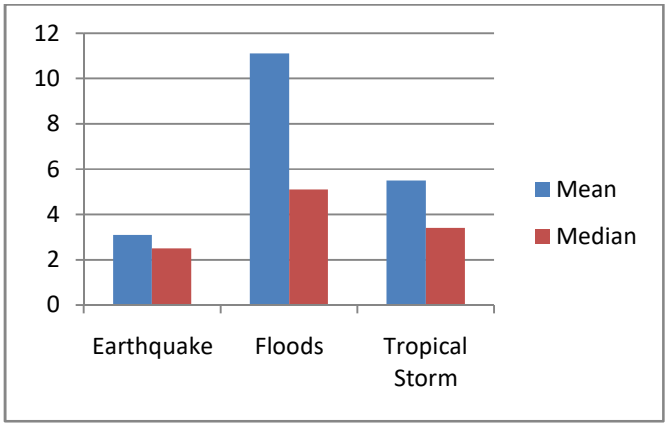


Fig 5.1: Benefit Cost Ratio of Benefits to Investment in Resilient Infrastructure
(Source: **Nolan** and Sriniasan 2019)

Financial Resilience: Adisaster for production process need not only the catastrophic event like Earthquake or Super Cyclone. A biological pandemic like Covid 19 can also result in disastrous conditions and the impact of disasters can be contained, but can not eliminated and therefore, the process of planning for emergency financing needs for reconstruction must always be made before the disaster strikes and few options may be explored, viz., a) to make provisions in the budget, possibly in the form of a dedicated saving fund to meet disaster needs, b) contingency-based financial instruments that provide insurance coverage or relief from debt service payments when a disaster strikes. But regional financial markets are often insufficiently developed to provide these financing options at a reasonable cost, particularly for small countries.

5.4Sustainable Development Goals

The time frame for the global agenda in the form of Millennium Development Goals was ended in 2015 and the United Nations General Assembly has adopted Transforming Our World: The 2030 Agenda for Sustainable Development‟ as a successor to the Millennium Development Goals. The Agenda was structured around 17 Sustainable Development Goals (SDGs) and 169 global targets that sets out areas to advance sustainable development and along with indicators to measure the progress. The Agenda represents a transformative plan of action for all countries and all stakeholders to implement. It sets poverty eradication as an overarching aim and has, at its core, the integration of the economic, social and environmental dimensions of sustainable development. This 2030 Agenda for Sustainable Development is being hailed as a positive and ambitious milestone for all regions and stakeholders. The UN Secretary-General describes the outcome as a “universal, transformative and integrated development agenda”. The Agenda recognizes and also reaffirms the urgent need to reduce the risk of disasters and recognizes various means and ways to reduce disaster risk. For instance, reducing exposure and vulnerability of the poor to disasters as measures towards the risk reduction. Unlike the previous development frameworks such the Millennium Development Goals that have overlooked the importance of reducing the impacts of disasters on society and economy, this agenda makes an effort to underline the impact of disasters on various parameters of the development such as the progress with reference to poverty, ending hunger, ensuring healthy lives, education, sustainable management of water, building resilient infrastructure, resilient cities, climate change, marine and terrestrial ecosystems etc., and established that about 25 targets have relevance to the disaster risks and 10 of the 17 SDGs are vulnerable to the disasters (Table 5.4 and 5.5).

Table 5.4: 17 Sustainable Development Goals (SDGs)

GOAL 1: No Poverty GOAL 2: Zero Hunger GOAL 3: Good Health and Well-being GOAL 4: Quality Education GOAL 5: Gender Equality GOAL 6: Clean Water and Sanitation GOAL 7: Affordable and Clean Energy GOAL 8: Decent Work and Economic Growth GOAL 9: Industry, Innovation and Infrastructure	GOAL 10: Reduced Inequality GOAL 11: Sustainable Cities and Communities GOAL 12: Responsible Consumption and Production GOAL 13: Climate Action GOAL 14: Life Below Water GOAL 15: Life on Land GOAL 16: Peace and Justice Strong Institutions GOAL 17: Partnerships to achieve the Goal

Source: UN (www.un-page.org)

5.5 Risk Reduction and Development Golas

5.5.1 Poverty and Disasters (Goal #1): *Poverty and disasters are closely interlinked. Poverty is a prime factors that creates and also increases* economic and social vulnerability. Evidence suggests that the*Disasters are known to* undermine hard-earned development gains in both developing and developed countries, potentially dragging the poor and most vulnerable even deeper into poverty. *It has been estimated that b*y 2030, about 325 million people trapped in poverty and exposed to the full range of natural hazards and extremes weather events, particularly in sub-Saharan Africa and South Asia (ODI 2013). Unless the resilience of poor communities is strengthened, more people will be pulled into poverty. Further, disaster resilience forms the backbone for eradicating extreme poverty. Promotion, strengthening and implementation of inclusive policies and social safety-net mechanisms through community involvement was suggested by Sendai Framework.

5.5.2 Hunger and Disasters (Goal #2): *India is prone to several natural disasters, from drought to hailstorms to cyclones. Every disaster is most likely to effect the first order economic activities and agricultural is the first order economic activity and every time a disaster occurs, significant losses are reported from farm sector with consequent losses in crop yield and which may have repercussions on food prices. Similar situations prevail in several countries and severe impacts* could destroy agricultural assets and infrastructure, causing serious damage to the livelihoods and food security of millions of small farmers, pastoralists and fishers in many developing countries. Things would turn severe if natural disasters cause of global food insecurity and hunger, also compound existing economic vulnerability (FAO 2011). Target 2.4 of SDG #2 stress on the need to advance actions in mainstreaming disaster riskreduction and climate adaptation into agriculture sector planning and investments in orderto promote resilient livelihoods, food production and ecosystems. Sendai Framework also recommends appropriate actions for strengthening productive assets such aslivestock, working animals, tools and seeds.

5.5.3 Health and Disasters (Goal #3): *Disasters have a direct impact on health and wellbeing of community. For instance, drought conditions result in malnourishment, flood conditions may create epidemics, Earthquakes may cause* injuries, psychosocial effects etc. Health infrastructure may also be affected by the disasters, thus disrupting and denying the communities with required health services. For instance, any damage to cold supply chain may have serious implications as Vaccinationsandprenatal medical care gets severely affected. Creation of disaster resilient health infrastructure can only help in building the capacities and resilience of communities (WHO 2011). Sendai Frameworkstress this aspect of the resilience of health systems and integration ofdisaster risk reduction into health care provision at

all levels.

5.***5***.4 ***Education and Disasters (Goal 4):*** *Disasters have a strong negative influence on the e*ducation. But the education has very important role in reducing vulnerability and building community resilience to disaster risks. Every disaster has potential to cause disturbances in livelihood base and thus force children out of school or damage the educational infrastructure or make the infrastructure non-available as they tend to be the first preferred shelters. In order to overcome these obstacles and ensure the progress of the education, educational infrastructure should incorporate disaster-resistant structures and adapt to local risks.

5.5.5 Gender and Disasters (Goal 5):In comparative analysis, disasters result in more suffering higher rates of mortality, morbidity in women and girls than the men and boys. According to UNISDR (2013) estimates, more than100 million women and girls are affected by the impacts of disasters every year due togender inequalities associated with socio-economic and cultural traditions. On the other hand, strengthening the role of womenand girls in the context of disaster risk reduction, is critical.

5.5.6 Water and Disasters (Goal#6): *Adequate supply of water on one ad hand proper sanitation facilities are essential components of a sustainable system. Inadequacies in any one of them is bound to reflect not only in health of the community but also would drastically alters the economic growth.* Sustainable water management is also critical in reducing the disaster vulnerability in drought prone areas and on other hand, ensuring proper sanitation is a compulsion to prevent the epidemics and spread of biological disasters. Water-relateddisasters such as floods, droughts, hurricanes, storm surges and landslides account forapproximately 90 percent of disaster events worldwide and dent the process of development severely (World Bank 2011).

5.5.7 Energy and Disasters (Goal # 7): Dr. HomiBhabha, founder of *Indian space industry has once commented that 'No Energy is costlier than no energy' and it is probably the most appropriate statement to underline the importance of quality energy for the progress of development and improvement in the quality of life. It is true that the consumption of energy causes environmental pollution, but with increasing technological developments, dependence on energy is ever increasing and it may not be far from ground reality to state that without electricity for more than 24 hours would lead to breakdown of major system globally. Disasters have the disruptive presence, and cause losses to the tune of b*illions of dollars invested in energy infrastructure year after year. One of important task in the aftermath of disasters is the restoration of electricity supply as it is lifeline for all other basic and emergency services (Evans et a 2014).

5.5.8 Livelihood and Disasters (Goal # 8): *For sustainable development, productive and gainful employment of all the members in working age group is important and in such a situation, both overall economy and also the individual growth and economic prosperity is ensured. However, with the development, there is a potential of more infrastructure becoming vulnerable to the disasters as well.* Global average annual losses from disasters are forecast to increase from US$260 billion in 2015 to US$414 billion by 2030 (UNISDER 2013).*On the other hand,* Trillions of dollars of new business investment is also expected to pour into hazard-exposed regions, largely determining the future of disaster risk and hence, investing in disaster risk reduction and resilience is imperative to ensure sustainable development and economic growth.At the macro-economic level, both private and public sector incurs losses from disasters due to destruction or loss of assets, capital and infrastructure etc. It may lead to slide in employment, economic activity and growth for many years after adisaster event. For instance, Covid 19 induced economic slowdown may take more than couple of years to come back to

pre-covid levels.

5.5.9 Innovation, Infrastructure and Disasters (Goal # 9): Adequate infrastructure facilities such as transportation system, communication networks, power, health and education facilities, are basic requirement for development and also the sustaining the growth of an economy. of a competitive economy. Estimates suggest that by 2030, annual investment requirements for infrastructure development are likely to total about US$53 trillion, an average of 2.5 percent of world GDP (UNISDR 2013). Incidence of disaster has a potential to upset this continuity of development by causing the disruptions, for instance, destruction of a bridge in a flash flood may stall supply chain for days or weeks, infrastructure fails during a disaster eventcan interrupt vital services, power failures may disrupt watersupply and transport during floods and cyclones (ADB 2013). Hence, it is vital forany economy to ensure that critical infrastructure is resilient to the impacts of disaster.

5.5.10 Habitat and Disasters (Goal 11): *Resource push and pull factors are pushing the urbanization in an explosive growth rate and* urbanization is expected to reach more than two-thirds of the world‟s population. The growing concentrations of people and economic opportunities in urban centers naturally increases the risk and vulnerability to disasters by many folds. Unplanned urbanization can add multiply the risk factor and illustrations of such risk can be seen during monsoon season in most of the Indian cities as they suffer from urban floods. Global urban development investment is also set to increase from US$7.2 trillion in 2011 to US$12 trillion by 2020 (UNISDER 2013). It is projected that by 2050, the urban population exposed to cyclones will increasefrom 310 million to 680 million while exposure to major earthquake risks will increase from370 million to 870 million (World Bank 2013). The exposure of urban assets to sealevel rise and flooding could reach US$35,000 billion by the 2070s which is ten times morethan the current levels (Nicholls 2007) and every measure should be incorporated into the plans to reduce the vulnerability.

Table 5.5: Select Development Goals and Targets for Risk Reduction

Development Goal	**Disaster Risk Reduction Target**
Goal 1: End poverty in all its forms everywhere	*Target 1.5: By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extremes and other economic, social and environmental shocks and disasters*
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	*Target 2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that held maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.*
Goal 3: Ensure healthy lives and promote well-being for all at all ages .	*Target 3.d: Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks*
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	*Target 4.7: By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and nonviolence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development. Target 4.a: Build and upgrade education facilities that*

	are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.
Goal 6: Ensure availability and sustainable management of water and sanitation for all	*Target 6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.*
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	*Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with focus on affordable and equitable access for all*
Goal 11: Make cities and human settlements inclusive,safe, resilient and sustainable	*Target 11.1: By 2030, ensure access for all to adequate, safe and affordable and basic services and upgrade slums. Target 11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries. Target 11.4: Strengthen efforts to protect and safeguard the world's cultural and natural heritage Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. Target 11.b: By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels. Target 11.c: Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.*
Goal 13. Take urgent action to combat climate change and its impacts .	*Target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries Target 13.2 Integrate climate change measures into national policies, strategies and planning*

Source: United Nations, General Assembly, *Transforming Our World: The 2030 Agenda for Sustainable Development,* A/69/L.85 (12 August 2015). Available at: www.un.org

Fig 5.2: Focus of SFDRR

5.5.2Initiatives to build Resilient Communities in Rural India

Inherently, due to its geographical situation, India is prone to several types of disasters and with changes in global climate change, various models have suggested that the frequency and intensity of disasters is most likely to increase and thus effecting the population and also the economy. With reference to the vulnerability to the disasters, urban counterparts are relatively better than their rural counterparts due to the presence of relatively better infrastructure facilities. Vulnerability of rural communities is double edged as both their physical safety and also the economic activities are exposed to the disasters and the consequent damages will be higher. Hence, as was discussed In earlier sections, if resilience of the rural community is enhanced, then not only their vulnerability would be reduced but also the return to the pre-disaster level would be much easier.

Resilience as a concept was evolved in natural science to indicate the capacity to return back to the normal phase after a disturbance. The concept was adopted in social sciences and now, it is been extended to various disciplines of knowledge. In disaster management science, the term Resilience refers “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions”. (UNISDR 2009). Resilience has become a useful approach for understanding the dynamics in the social ecosystem and provides an insight into the ability of the social ecosystem to self-organize, learn, and adapt. Similarly, the Community resilience, as a collection of a series of capabilities, is also a process of community capacity

improvement and disaster adaptation, and can be used as a community development goal (Folke 2006, Berkes 2013). The resilience of a community in respect to potential hazard events is determined by the degree to which the community has the necessary resources and is capable of organizing itself both prior to and during times of need. and now to economics, psychology, planning, and other fields. Among them, the focus is on improving the ability to respond to climate change and building resilient communities that are resistant to natural disasters (UNISDR 2009) and by improving the resilience of rural India, its vulnerability to disasters can be effectively reduced. Rural resilience may be defined as the capacity of a rural region to adapt to changing external circumstances in such a way that a satisfactory standard of living is maintained. It can be described by how well a rural area can simultaneously balance ecosystem, economic and cultural functions (Colding 2017). Changes in resilience of one domain will effect the resilience in other domains as well. For instance, if a rural community is economically not resilient, then a sudden drop in farm produce likely to create economic shock and similarly, the village is ecologically not resilient, its farm production would be effected and vulnerability of village will increase. Cultural resilience is a necessary condition for rural resilience as it indicates adequate human capital. Therefore, All in all, reducing resilience – be it economic, ecological or cultural – would increases vulnerability of rural community and all the measures that aim at them can be termed as measures for enhancing the rural community resilience.

Fig 5.3: Rural Resilience
(Source: Heijman et al 2019)

The communities are first one to be exposed and they are also the first ones to respond. This aspect has been underlined in the Second World Conference on Disaster Reduction at Hyogo, Japan in 2005 and resilience assessment and resilience community construction at the community level was stressed as essential strategies for disaster prevention and reduction (UNDRR 2015). Importance of community resilience was again stressed upon in the "Sustainable Development Summit" in New York in 2015 that adopted the United Nations Sustainable Development Goals (SDGs), and the 11th goal focus on resilience. The Paris Climate Change Conference through its Paris Agreement, has called for strengthening communities' ability to respond to global change as a priority for post-disaster recovery and reconstruction (Liang Zhao et al 2020)

5.5.3 Strategies for Rural Resilience: We can broadly divide various measures that address rural resilience into following five categories;

1. **Improved natural resource conservation**: Conserving and regenerating land and water resources enhances their productivity, leading to increased agriculture outputs and improved livelihoods derived from agriculture, forests and pastures. Schemes were drawn in a manner to reduce run-off and soil losses, recharge groundwater, increase vegetative cover and improve biodiversity, so that they can contribute to augment the ecosystem productivity.
2. **increased efficiency of resource use**: Rural development schemes can substantially improve the efficiency of natural resource use in rural livelihoods and essential services. Under IWDP, there is opportunity to support farmer groups to adopt practices that improve efficiency of irrigation water. This can be done through appropriate crop choices, farming techniques, drip and sprinkler irrigation systems and improved field irrigation methods. Under NRLM, women's self help groups and farmers can be supported on efficient nutrient management by combining chemical inputs with organic inputs. Under MGNREGS, soil erosion can be reduced leading to lower run-off of chemical fertilizers and higher yields per unit of applied chemical fertilizer.
3. **reduced negative environmental impacts**: Greening Rural Development schemes can potentially reduce the negative environmental fall-out of economic development (pollution, waste generation etc.). Solid and liquid waste management in the Nirmal Bharat Abhiyan (formerly the Total Sanitation Campaign) improves local sanitation and hygiene and thereby, the well-being and health of local residents. In the Indira AwaasYojana, the use of locally-available resources such as rice husk ash and flyash reduces diesel required to transport manufactured materials over long distances, and thereby, environmental pollution. Organic farming and sustainable harvesting of NTFPs under NRLM and the use of renewable energy for lifting water in NRDWP are other examples.
4. **iv. Strengthened climate resilience of communities:** Greening rural development schemes can potentially enhance the resilience of rural population and production systems, and reduce risks arising from climatic variations and extreme events such as droughts, floods and cyclones. Afforestation, plantations, fodder development and vegetation belts in coastal areas under MGNREGS, IWDP or NRLM build livelihood resilience and improve local communities' coping capacity to potential impacts of climate change. They also increase biodiversity and make the local ecosystems more resilient. Flood control measures under MGNREGS and IWDP enhance resilience in flood-prone areas.
5. **Contribution to climate change mitigation:** Large-scale forestry and soil conservation measures can sequester carbon and reduce greenhouse gas emissions. For example, afforestation, plantations and vegetation belts under MGNREGS and IWDP can help sequester carbon and contribute to national and global efforts to address climate change.

Programs for Enhancing the Resilient Communities

- **Mahatma Gandhi National Rural Employment Guarantee Programme (MGNREGS)** envisages large investments in soil and water conservation, land development and afforestation activities that address the causes of chronic rural poverty. It also lays stress on creating durable assets. These key elements of the Act -- productivity enhancement and sustainability of the rural natural resource base - strengthen its potential for green outcomes. It is the largest rural development programme in the country in terms of its reach and budget. A vast majority of MGNREGS works are 'green' in nature given their focus on the regeneration and conservation of natural resources and ecosystems and their main emphasis being on land (farmlands, forests, pastures and waste lands) and water resources. In fact, since the initiation of MGNREGS more than 50 percent projects are related to water through implementation of water conservation works, flood control, irrigation, drought proofing, renovation of traditional water bodies and micro-irrigation.38 Their main developmental consequences are higher crop productivities and

production.39 Drought proofing activities, floods management works and vegetation belts planted in the coastal areas also reduce the potential damage due to extreme weather events.

- **National Rural Livelihood Mission (NRLM)**was launched in 2011, aimed at creating efficient and effective institutional platforms of the rural poor enabling them to increase household income through sustainable livelihood enhancements and improved access to financial services. Focus has been on three key livelihood components of the NRLM mainly livelihoods based on non-timber forest produce (NTFP), sustainable agriculture and non-farm employment.
- **Integrated Watershed Development Programme (IWDP)**The main objectives of the IWDP are to restore the ecological balance by harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and water. The outcomes include prevention of soil run-off, regeneration of natural vegetation, rain water harvesting and recharging of the ground water table. This enables multi-cropping and the introduction of diverse agro-based activities, which help to provide sustainable livelihoods to the people residing in the watershed area.

- **Improving Soil Health** Soil conservation is only the first step in regenerating soils and has to be followed by a comprehensive approach for improving soil health that involves (i) applying organic inputs; (ii) enhancing soil fertility by using easily adaptable good agronomical practices; (iii) creating an incentive systems for producing organic fertilizers and their use; (iv) establishing support systems for capacity building, market linkages and storage facilities.

- **Going beyond Increasing Water Availability to Water Security:** The IWDP has successfully promoted rainwater harvesting to augment water availability but there is a need to move towards water sufficiency or security. This includes assessment of groundwater potential mapping of aquifers, drainage lines and surface water bodies and assessment of current water resource use demand of all kinds. Further, the irrigation action plans should aim at providing critical protective irrigation to a maximum number of farmers rather than providing intensive irrigation to small pockets of lands Since water resources augmentation is a major outcome of IWDP,

- **Biomass and Biodiversity Conservation** A priority objective of watershed development is to regenerate and restore the productivity of degraded lands. So far, the focus has been largely on soil and water conservation works, afforestation and plantations have not received adequate attention. The planting activity is done without much participation of the main stakeholders, i.e., the local communities, leading to very poor survival rates. Inadequate efforts at institution building, community participation in planning or selecting the species for planting, specifying usufruct rights and establishing remunerative links with livelihood activities are at the root of the stakeholders' alienation.

- **Green Livelihoods** Agriculture and livestock-based livelihoods have been the main beneficiaries of watershed development programmes in India so far. Soil and water conservation have increased irrigation water, which in turn, has helped enhance agricultural production and productivity. Increased fodder availability from farms and newly afforested areas has increased dairying activities and incomes. However, many of these successes have been based on high chemical inputs particularly fertilizers and pesticides, besides major dependence on irrigation. Greening IWDP would mean a shift towards low external inputs environmentally sustainable

agriculture (LEISA). Generic practices like LEISA or low carbon farming do not compromise the productivity of farm lands while strengthening their ecosystems.

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Glossary

Capacity
The combination of all the strengths, attributes and resources available within a community, society ororganization that can be used to achieve agreed goals.

Capacity may include infrastructure and physical means, institutions, societal coping abilities, as well as human knowledge, skills and collective attributes such as social relationships, leadership and management. Capacity also may be described as capability. Capacity assessment is a term for the process by which the capacity of a group is reviewed against desired goals, and the capacity gaps are identified for further action.

Capacity Building
It includes (i) identification of existing resources and resources to be acquired or created; (ii) acquiring or creating resources identified under (i); (iii) organization and training of personnel and coordination of such training for effective management of disasters

Capacity development
The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions.
Capacity development 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 social and cultural enabling environment.

Disaster
Disaster means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area

Disaster Management means a continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary or expedient for—
prevention of danger or threat of any disaster;

- mitigation or reduction of risk of any disaster or its severity or consequences;
- capacity building
- preparedness to deal with any disaster;
- prompt response to any threatening Disaster situation or disaster;
- assessing the severity or magnitude of effects of any disaster;
- Evacuation , rescue &relief
- rehabilitation and reconstruction;

Disaster management can also be defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters.

Disaster Risk Reduction
The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Early warning system
The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Hazard
A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Resilience
The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Vulnerability
The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard

Editors' Profile

Dr W G Prasanna Kumar

Dr. W G Prasanna Kumar, Chairman, Mahatma Gandhi National Council of Rural Education (MGNCRE) prides in calling himself a *Public Servant* working for Climate Change. His expertise in Disaster Management has him in the advisory panels of several state and national level departments. He is also an expert advisor for the government of Telangana in its Disaster Response Force endeavour. A master trainer for Civil Services candidates, he conducts intensive training programs periodically at the behest of nationally recognized training institutes. He is currently actively involved in promoting higher education curriculum addressing rural concerns in India. **"Villagers to be producers not just consumers"** is his conviction that drives him to work for rural challenges. He aspires for an adaptive disaster risk resilient and eco-responsible India. The Curriculum on MBA in Waste Management and Social Entrepreneurship, and BBA and MBA in Rural Management are his major academic achievements dedicated to India's rural concerns. This has culminated in several collaboration MOUs for introduction of MBA/BBA Rural Management in Higher Education Institutions across India.

Dr. Prasanna Kumar excels in taking a vision and making it a reality and a plan into action, driven by a strong motive to achieve. He has translated positive intentions into tangible results. Being clear on the vision, defining a pathway, setting of the track with a clear destination point and quickly taking corrective actions as and when needed – are his prime qualities that make him an Achiever.

Under Dr. W G Prasanna Kumar's leadership MGNCRE has done nationally recognized instrumental work in building rural resilience including rural community engagement and Nai Talim - Experiential Learning. He has guided and helped MGNCRE in making key decisions and implementing agenda in several areas including Nai Talim (Experiential Learning), Community Engagement, Rural Immersion Programmes, Swachhta Action Plan activities, Industry-Academia Meets and Exhibitions on Waste Management, Comprehensive Sanitation Management in villages by working with Higher Educational Institutions, making curricular interventions in Waste Management and Rural Management, compiling Text Books on Waste Management and Rural Management, UNICEF (WASH) activities and several other related impactful activities. MGNCRE has become an interface for Government of India for promoting academic activity focusing on the rural concerns, being an advisor and a curriculum development agency for the Government of India. The Council is also now an RCI for Unnat Bharat Abhiyan.

Another pathbreaking achievement has been the formation of **Cells** through online workshops for institutionalising the efforts of MGNCRE. Vocational Education-Nai Talim-Experiential Learning (VENTEL) discuss MGNCRE's interventions in HEIs and making Vocational Education as a Teaching Methodology; Workshops on Social Entrepreneurship, Swachhta and Rural Engagement related activities in Higher Education Institutions has paid dividends and the key roles of the HEIs is highly appreciated by the Ministry. Building continuity and sustainability is being done through Social Entrepreneurship, Swachhta & Rural Engagement Cells (SES REC). Institutional level Rural Entrepreneurship Development Cells (REDC) Workshops/ FPO/FPC-Business Schools Connect Cells (FBSC) are organized with the objectives of

Functionality of RED Cell; Preparation and Implementation of Business Plan and grooming students to be Rural Entrepreneurs.

A man with many firsts to his credit, and an incredible record of accomplishments, Dr. W G Prasanna Kumar is currently guiding MGNCRE in building a resilient rural India.

Dr K N Rekha

Dr K N Rekha, is a PhD Graduate from IIT Madras. She has 14 years of experience in training and education Industry. She works at Mahatma Gandhi National Council of Rural Education (MGNCRE), Hyderabad as Senior Faculty. She is involved in curriculum development on Rural Management and Waste Management. Prior to this, she worked as a researcher at Indian School of Business, Hyderabad, a short stint at Centre for Organisation Development (COD), Hyderabad. She has co-authored a book on "Introduction to Mentoring", written book chapters, peer reviewed research papers, book reviews, Case studies, and caselets in the area of HR/OB. She also presented papers in various national and international conferences. Her research areas include Mentoring, Leadership, Change Management, and Coaching. She was also invited as a guest speaker at prominent institutions like IIT Hyderabad.

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Dr Lenin Babu

With masters degree in Environmental Biology and Docoatroal Degree in Environmenal Sciences, Dr Lenin Babu was assoicated with various organziations, varying from enforcemnt agency – Central Pollution Control Board, Delhi, Academic Institutions – National Law School of India University, Bengalore, Bengalore University,Bangalore, Karnataka State Women's University, Vijayapura and moninotirng ogranizations like Karnataka State Natural Disaster Monitoring Center, Bangalore. Currently, he is assocated with Institute for Social and Economic Change, Bangalore.

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