

3.0 INTRODUCTION:

The concept of Disaster management is focused on mitigation/reduction of disaster risk. Disaster risk reduction (DRR) can be defined as a systematic process using administrative & operational skills to implement and use strategies that lessen the impact of natural or man-made disasters. “DRR comprises of all forms of activities including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects to hazards” (UNISDR, 2004). There are three key stages of activities in disaster management:

- 1) **Before a disaster (Pre-Disaster stage):** To reduce the potential for human loss, collateral, or environmental losses caused by hazards and to ensure that these losses are minimized when disaster strikes.
- 2) **During a disaster (Emergency Stage):** To ensure that the needs and provisions of victims are met to alleviate and minimize suffering; and
- 3) **After a disaster (Post Disaster Stage):** To achieve rapid and durable recovery which does not reproduce the original vulnerable conditions.

This approach of studying the disaster management process cyclically (referred to as the Disaster Management Cycle) has given a holistic approach to managing the disaster and has helped in developing a judicious blend between developmental activities and disaster management. In other words, the essential link to reduce disaster is to bring in effective planning that eventually leads to mitigation of vulnerability, like poverty reduction, education, and employment provisions which are also mainstream development concerns. Consequently, the disaster management cycle implies development is essentially related to disaster management.

The concept of the disaster management cycle facilitates a planned approach towards the various phases of the disaster. They are interwoven strategies for all the phases and require the coordination of all the stakeholders from individual to national level players. The Pre-disaster activities involve Prevention, Mitigation & Preparedness. Whereas the Post-disaster Stage encompasses Response, Relief, Rehabilitation &

Recovery. For successful disaster management, the planning realm should include all the vital activities during the pre and post-phase of a disaster. Any delude will obstruct the future development activities of the affected region. With proper resource allocation & depending on the magnitude of the disaster that has struck, human intervention can bring down the vulnerability and susceptibility.

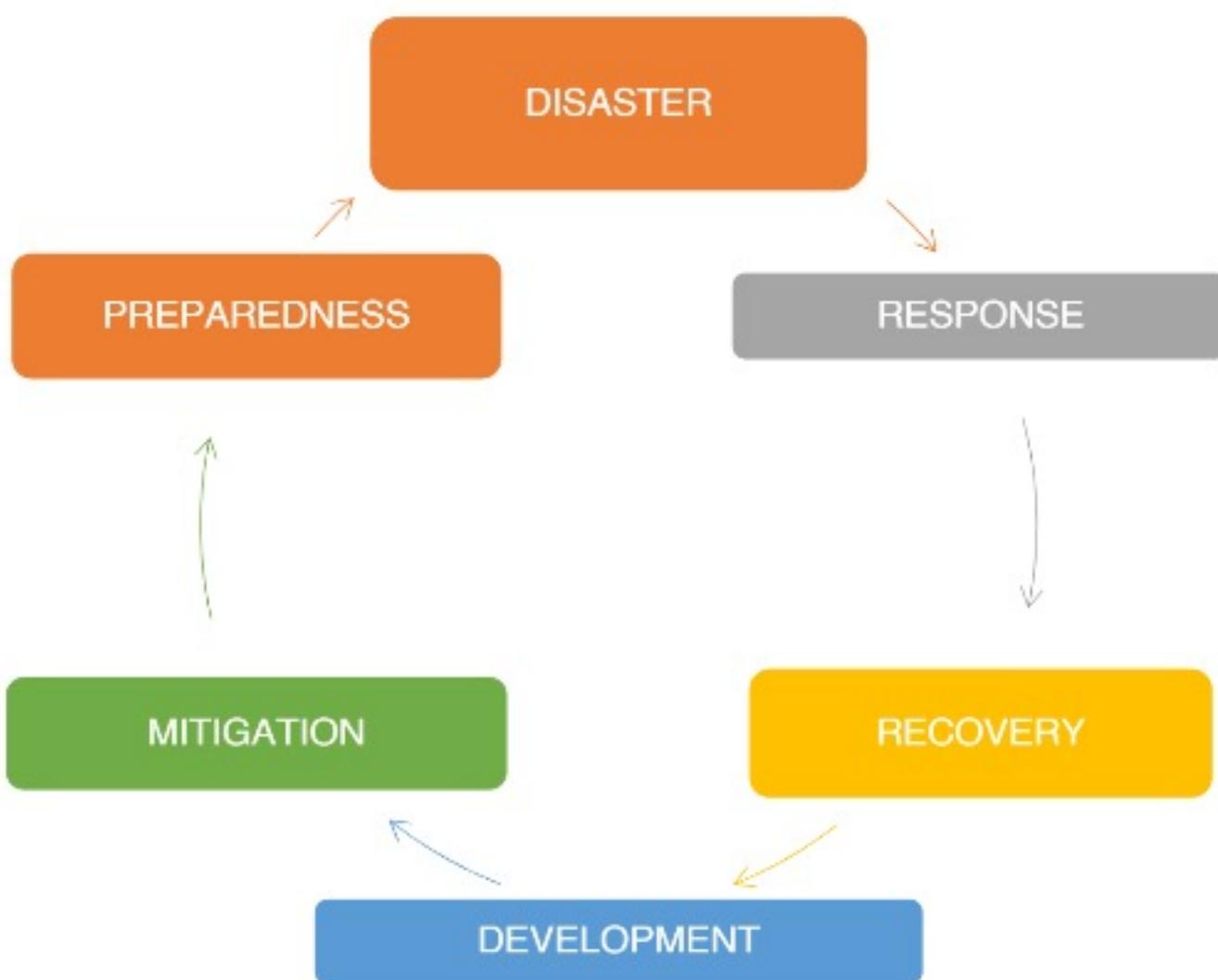


Figure 3.1: The Disaster management cycle

3.1 Pre-disaster Stage (Preparedness)

Pre-disaster management is a stage where the consequence of disaster is anticipated & the disaster risk of the area, and its vulnerability is foreseen. Pre-disaster management essentially involves three activities:

- Prevention
- Mitigation
- Preparedness

The phase is essentially focused on reducing the human and property-related damages caused by a potential hazard. It involves organizing a response operation to provide maximum readiness for as many hazards as possible. It involves all the potential stakeholders including civic bodies, administration, hospitals, police & the workforce of fire brigades. This phase of disaster management includes planning & developing a strategy to manage the predicting a disaster and recovery related issues after the hazard strikes in terms of provision of basic amenities & essential services, provision of temporary housing facilities, and re-establishing the economic activities. It also involves awareness programs, training, and educating the local public regarding disaster preparedness, mock drills & other activities. The details of the activities involved in the Pre-Disaster phase are discussed in the forthcoming pages. The preparedness stage aims to detect tasks and specific activities covering organizational and scientific issues to ensure that response systems function successfully in the event of a disaster.

3.1.1 Preparing Hazard Zonation maps

The mapping of an area that is likely to be susceptible to a hazard is known as a hazard map. These maps are typically created for natural hazards like landslides, floods, forest fires, earthquakes, and volcanoes. These maps aim to help in disaster pre-preparedness, to prevent any serious damage or death. In India, ISRO has prepared Landslide, cyclone, tsunami & Flood Hazard Zonation maps.

Description of a few hazard zonation maps are as follows:

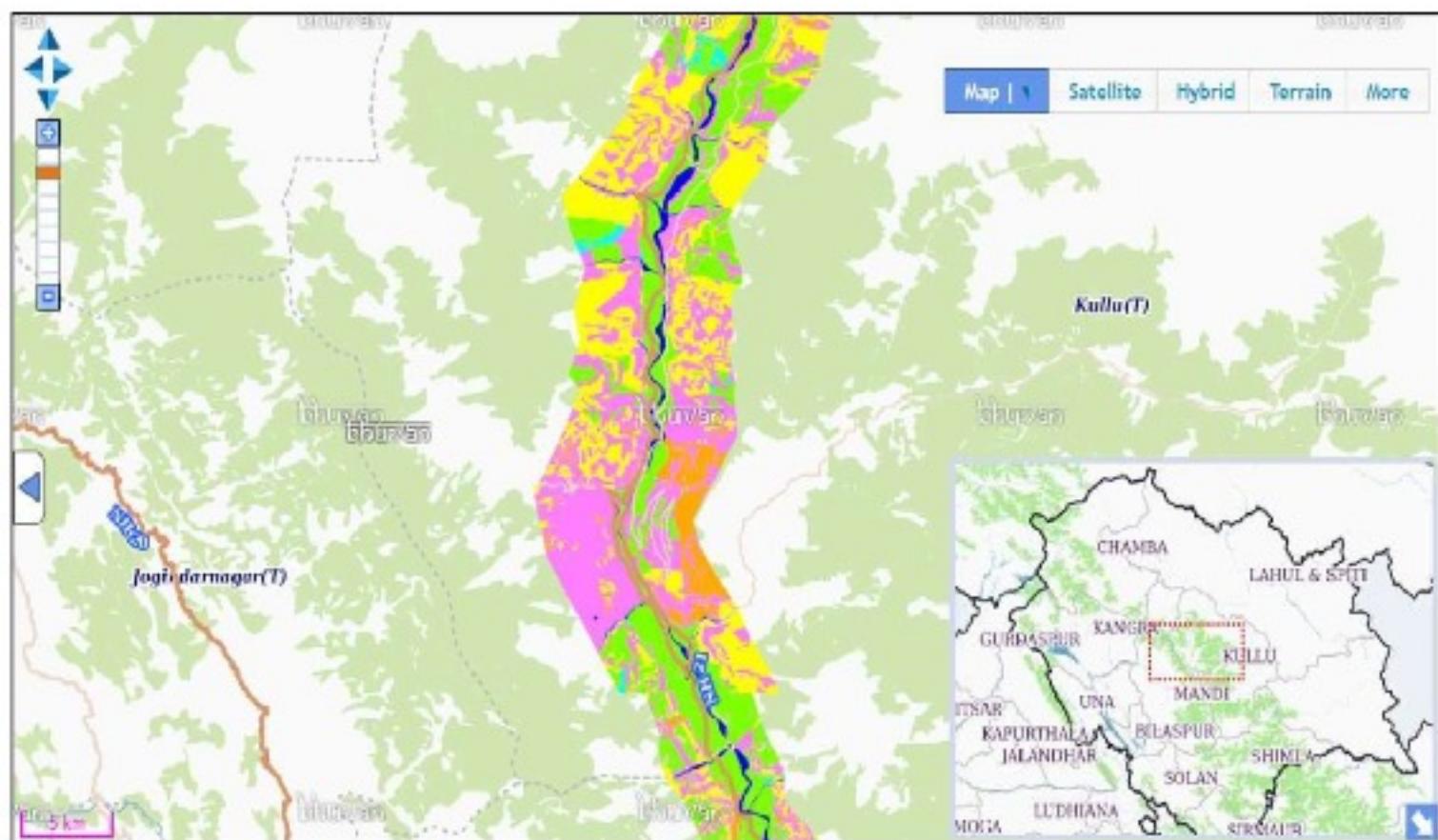
- **Landslide Zonation maps:**

Land Hazard zoning refers to the subdivision of the terrain in zones that are characterized by the temporal probability of occurrence of landslides of a particular size and volume, within a given period. Landslide hazard maps should indicate both the zones where landslides may occur as well as the runout zones. For a given area, hazard maps contain detailed information on the types of landslides, the extent of slope subject to failure, and the probable maximum extent of ground movement.

- These maps can be used to predict the relative degree of hazard in a landslide area.

- Areas may be ranked in a hierarchy such as low, moderate, and high hazard areas.

The Hazard zonation map for pilgrim routes in Himachal Pradesh, Uttarakhand, and Meghalaya is prepared by ISRO. In addition, ISRO is also preparing seasonal landslide inventory on regular basis. These satellite-based inputs are very useful for preparedness.



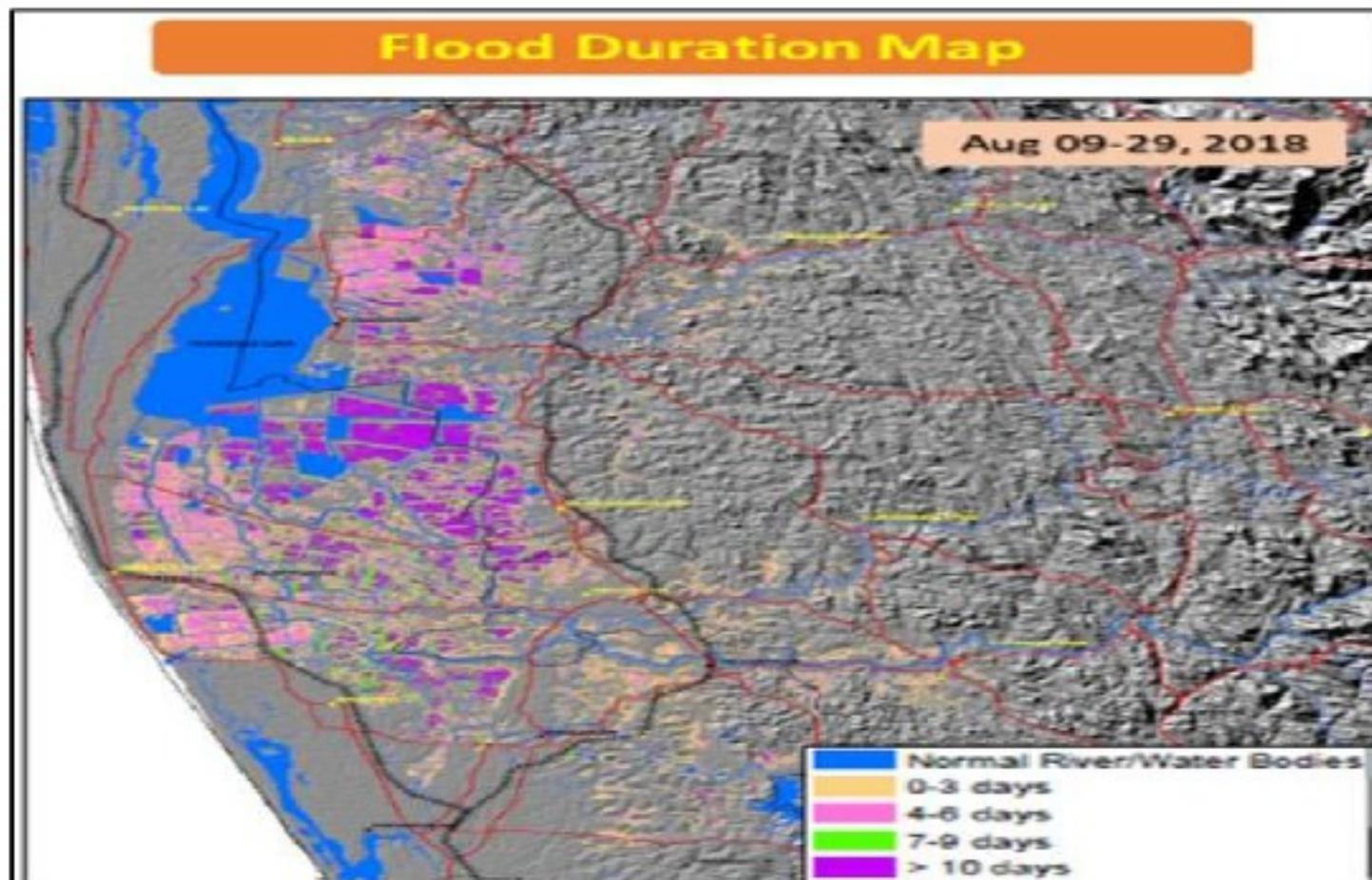
Source: <https://www.isro.gov.in/landslides-Hazard-zones>

Figure 3.1: Landslide hazard zoning map of pilgrimage route in India

- **Flood zoning map:**

The most ideal course in dealing with floods is to define several zones within the flood-prone area, depending on the velocity of the river and certain other physical factors. The flood-prone area may be classified as components like floodway and flood plain. A floodway is the normal river channel and an expanded high-water area. It is identified using flood frequency or extreme event information. It is that part of the flood-prone area that usually has high velocities, high potential for soil erosion, and high exposure to the flow of significant quantities of debris. A flood plain is that residual area outside of the floodway wherein the water velocities are usually less. In this area, flood

protection activities, as well as flood-proofing measures, may be considered. Zoning a river based on a floodway and flood plain is known as a two-zone approach. The ISROs flood zoning map with the duration is shown below:



Source: <https://www.isro.gov.in/Flood-Inundation-Kerala>

Figure 3.2 Flood inundation map of the Kerala state

The major steps involved in the preparation of the flood hazard zonation maps was - Satellite data acquisition: Satellite data (from 1998 onwards) was acquired from the Indian Remote Sensing (IRS) satellites for the period during which floods took place.

Hazard zoning can be similarly done based on seismic activity, volcanic activity, and forest fires. In India, based on seismic activity India has been classified into 5 zones and the same has been discussed in detail in Unit1.

3.1.2 Predictably/forecasting and warning

An important milestone in disaster risk reduction is early warning and prediction. Though man can't prevent the occurrence of a disaster, there is certainly a possibility to reduce the disastrous impact of disasters through adequate preparation and timely action that would be based on an accurate forecast. The effectiveness of pre - preparedness for disaster is enhanced by prompt warnings and forecasts. An

important matter that needs to be borne in mind is that- not all disasters can be predicted, and only those which have inherent predictability like cyclones can be predicted.

One needs to differentiate between the three key variables that are interchangeably used once the discussion regarding mitigation of risk comes into the picture viz. Predictability, Forecasting, and Warning

- **Prediction:** Predictability is based on understanding the surrounding nature and thereby assessing the occurrence of the disasters related to it. To predict man-made disasters, an insight into human errors and mechanical faults is to be investigated.
- **Forecasting:** Any natural disaster that has inherent predictability, forecasting is the next step. For forecasting, scientific, and operational techniques are a mandate. Once the forecasting is done, it must be communicated to the people of the susceptible region at the earliest
- **Warning:** Once fact-based forecasting is done, the information regarding the anticipated disaster should be converted into a warning within a given time frame and should be signaled out to the users at the earliest. Various color codes are used by the IMD (Indian Meteorological Department) to issue warnings.
 - Green: There is no likelihood of adverse weather
 - Yellow: This signals that there is a likelihood of weather change that could stretch over a few days
 - Orange: Warning for extremely bad weather with disruptions in electricity, transport & communication
 - Red: The highest level of warning to act immediately as they would be life-threatening conditions

The very purpose of an early warning system is to forecast and issue alerts to the people in susceptible areas regarding an impending hazardous event. The information must back with factual data, so to prepare people for a mitigation strategy to avert the risk of the hazard. Besides, the warning has been issued and communicated on time for timely action to be taken by the vulnerable group. Numerous agencies help in

issuing forecasts & warning regarding the hazards viz. Meteorological offices (Weather-related forecasts), Health agencies (Diseases, Pandemic related forecasts), Media & local and indigenous sources. An early public warning must be done with due diligence since it will create panic and chaos. The planners must consider the perceptions of the public before going public regarding the hazard.

Numerous examples can be seen across the world regarding the benefits of an early warning system and how they helped to mitigate the risk. A good instance of how disaster preparedness has helped save many people's life can be explained with the example of how the Andhra Pradesh government managed the cyclone. The government with the help of local community members , were able to evacuate lakhs people within 40hrs of receiving a warning about an oncoming cyclone. With excellent meteorological forecasts and warnings, with the coordination of many stakeholders backed by an efficient plan, they were able to mitigate the risk of the cyclone. Fatalities numbered less than one-tenth of the more than 10,000 people who perished in a similar cyclone 13 years before. Another instance that can be cited is the prediction of drought situation El Niño conditions. Severe drought and associated food insecurity, flooding, rains, and temperature rises due to El Niño are causing a wide range of health problems, including disease outbreaks, malnutrition, heat stress, and respiratory diseases. From the past few years with accurate forecasting and warning countries across the globe have been well prepared to face these situations.

Scientific and technological advances in recent decades have greatly improved the nation's capability to predict most natural hazards and disseminate warnings based on those predictions. However, prediction accuracy and lead times vary with the type of hazard. Prediction capabilities for atmospheric and hydrologic events are generally more advanced and specific than those for their geologic counterparts. Currently, governmental and private organizations are relying on Artificial Intelligence to predict the occurrence of natural disasters. Google in India is building an AI-based platform to predict floods and also gauge the intensity of the flood, simultaneously it is working on giving a warning to the users via google maps & google search. AI has been instrumental in analyzing the magnitude of the seismic activities and helps in the prediction of earthquakes, volcanic eruptions & tsunamis. It has also helped in

predicting the intensity of cyclones/hurricanes in the recent past. The adoption of AI to predict natural disasters will save millions of lives. Additionally, the datasets analyzed by the AI-powered systems will help in understanding the magnitude and the patterns of natural disasters such as floods, earthquakes, and tsunamis, which can help in better planning of infrastructure in disaster-prone areas. Thus, government organizations need to deploy AI to predict natural disasters and monitor them accurately to ensure the safety of their citizens.

3.1.3 Preparing Disaster Preparedness Plan(DPP)

The need for Disaster Preparedness Plan(DPP) is self-apparent. The experiences of people on the national and international front have revealed that whenever there is inadequate planning or lack of a plan the disastrous impact of natural/manmade calamities has been very high in terms of death toll and devastations that are caused. Hence, we need to be well prepared to face disasters, and it is aimed at improving response activities and coping capacities of the people living in the susceptible area

A disaster preparedness plan essentially contains measures to be taken before, during, and after disaster strikes. It is a strategic plan that involves identifying organizational resources, determining roles and responsibilities, developing policies and procedures, and planning preparedness activities aimed at ensuring timely disaster preparation and effective emergency response. The plan aims to see that there is proper coordination and interaction between the various parties involved and the response system functions effectively when the disaster strikes. The plan also encompasses a list of the inventory needed, the details of people to be contacted (NGOs, Government agencies, local coordinators), and helpline numbers. It should also give guidelines for temporary shelters, health care centers, social workers to be contacted. Creating awareness about the potential hazards is an important element of the disaster preparedness plan.

The activities associated with Disaster Preparedness are the following:

- Developing planning processes that ensure readiness
- Formulating appropriate disaster plans
- Stockpiling the necessary resources for effective response,

- Developing skills and competencies among individuals and community members to ensure effective performance of disaster-related tasks.

Disaster Preparedness Plans also contain certain long-term, wide-ranging measures to be carried out. It includes measures like construction of embankments along rivers, retrofitting of houses, periodic inspection of critical river stretches, establishing a system of communication, construction of relief centers, and land-use measures.

The Elements that must be addressed in the preparedness plan includes:

1. The required authorities are empowered to address the emergency.
2. Identification of the Hazard that will occur in the area, and assess the risk and potential threats on the infrastructure and population
3. Identify all possible steps to mitigate the risk at the individual, community, state, and national level
4. Proper management of resource allocation. In many cases, during a disaster, the paucity of resources is not the problem but improper management of the same aggravates the issue.
5. Effective direction, coordination, and management of all activities
6. Proper communication and early warning systems are necessary for effective disaster management
7. Proper operations and procedures such as training, mock drills, and other awareness programs must be framed for the community
8. Proper logistics and related facilities should be placed so that it will help the victims
9. The officials, volunteers, and the members of the community should be provided with the required training so that they are well prepared for any eventualities
10. Communications resources are critical for all response activities at different levels. Proper infrastructure will facilitate periodical communication and information, and education of the public.
11. There should be adequate and appropriate allocation of finance and its proper administration.

The Disaster preparedness shall be complete only when it starts its implementation at the household level and grows till the business level. The individual members need to be made aware of the hazard, response plans, and emergency measures. They must be updated about safety plans, emergency coping mechanisms, restoration plans & methods to recover from the disaster.

3.1.4 Land-Use Zoning

Land-use zoning is a method used by the government to classify plots of land and restrict the physical development or use of the land, to prevent exploitation. Land-use zoning in India is *Euclidean* based, which means that it creates land use classifications (i.e., residential, commercial, recreational, etc.) by geographic area. It also sets the legal framework. The zoning ordinance establishes permitted land uses and distinguishes between different land-use types.

The purpose of zoning is to allow local and national authorities to regulate and control land and property markets to ensure complementary uses. Zoning can also provide the opportunity to stimulate or slow down development in specific areas. The planning and zoning process functions differently around the world and is controlled by different levels of authority.

Land use planning is a newly emerging disaster reduction method. Land use planning is a potentially powerful mitigation tool as it seeks to mitigate the risks and vulnerability from several geological and other hazards. So, the logic of land use planning is compatible with disaster risk reduction because both are systematic, future-oriented, decision-oriented, and proactive. Land-use zoning for disaster prevention and mitigation may act as a spur to comprehensive land-use planning, more so in disaster-prone regions. The major elements of land-use planning may be summarized as follows:

- i) Land-use policies and plan setting. Out the social, economic, and environmental goals of comprehensive land development and their stages of development

- ii) Land ownership and land tenure patterns identifying the legal, social and economic basis of ownership and tenure
- iii) Land values and prices, reflecting the forces of supply and demand for land; and
- iv) Land-use controls may be subdivided into three broad categories, i.e., legal, fiscal, and directive.

Regional policies emphasize local considerations and correspondingly appropriate physical planning and hence are particularly relevant for disaster management. Major components of regional policies include the selection of areas designated for transport networks, industry, agriculture, and urban growth. The area aspects of regional planning are a vital link to national planning efforts and constitute a basic means of implementing disaster prevention policies.

Zoning controls:

Zoning and sub-division control are means by which government can regulate, and control both land use patterns and development in both rural and urban areas. Legal controls are increasing to regulate the activities of the private sector by placing location restrictions and minimum standards on specific types of land uses and activities. These controls can take the following forms:

- **Land Use Macro Zoning:**

Land Use Macro Zoning Macro zoning is the establishment of land use planning zones at regional levels. Such zones generally establish agricultural, urban, industrial and recreational uses incorporating existing and future patterns. Specific uses are allowed in designated areas, although macro-zoning plans are revised at appropriate intervals to take into account changes and growth. Such zoning is an efficient tool to control the overall location of various human activities. Macro zoning has a broad function in the reduction of risk since hazardous areas can be zoned permanently for agricultural or recreational uses, minimizing as far as possible urban or semi-urban concentrations of population or industry.

- **Land Use Micro Zoning:**

Micro zoning is the detailed preparation of land use maps by local bodies and 'public authorities, particularly in urban settlements, fixing specific land - uses for each site (such as residential, educational, commercial, etc.). Micro zoning also details the density of land uses at sites. Furthermore, micro zoning establishes a detailed land use pattern within the natural hazard macro-zoning framework. From the point of disaster prevention, micro zoning is a basic tool that relates natural hazard assessment to land-use planning. Detailed risk analysis for given locations assists in determining both land-use and building criteria. It can be said as a general rule, that whereas natural hazard macro-zoning maps are based on the broad geological and geographical configuration of a given region coupled to records of past hazard frequency and magnitude, natural hazard micro-zoning is essentially a detailed study of the probability of natural hazards in a given site as determined principally by the detailed study of sub-soil conditions.

As a basic principle, major functional land uses should be segregated and not mixed as far as possible. Mixing of land uses, especially between residential and high-risk industrial, should be avoided. All such industrial plants and storage areas of explosive and combustible material and substances should be separated from residential development by a system of green belt. The density of development in a disaster-prone area should be kept as low as possible. In case of a conflict due to economic criteria (cost of land and infrastructure) or with functional demand (accessibility or proximity) the compromise, if unavoidable, should be a function of the level of risk in the area, building technology and material, and height of buildings and cost of infrastructure.

3.1.5 Preparedness through Information, Education, and Communication (IEC)

The goal of any disaster management initiative is to create a disaster-resilient environment and equip people with safer living conditions and create a sustainable environment to help foster development. For this goal to be understood and to be

disseminated across the population this must be communicated to the citizens. Hence, Information, Education, and Communication, (henceforth referred to as IEC), is a strategy that is used to spread awareness about Disaster Mitigation & management, through various channels to achieve the goal. The IEC relies on the transmission of the information through print media, broadcasts on radio, interpersonal communication, use of flyers, posters, brochures, and billboards. Before getting into the nuances of the modes of IEC, let us discuss the basics of IEC

- **Information**

Proper planning is built on the edifice of the factual data and in the case of disaster management, pre-preparedness is based on efficient planning. Information refers to any data, description, maps, or sketches that are systematically collected, organized, verified, and analyzed regarding any hazard. The details of hazards like floods, cyclones, hurricanes, etc. with their frequency of occurrence, the risks involved, and their causative mechanisms are listed in the information. Information can be in the form of descriptive details, probabilistic based, or can include qualitative details. Basically, “Information” in IEC addresses -Why, When, Where How & what of the occurrence of a disaster. National Institute of Disaster Management has issued several leaflets and publications detailing various information’s about all the natural disasters that occur in India.

Information forms the varied base from which knowledge is derived and action plans are formulated for carrying out the operational tasks of disaster management. This input in the form of information is essential during all the phases of disaster management that are pre-stage, emergency stage, and post-stage. Hence relevance is not kept only for the collection of data but also for efficient analysis and dissemination of information so that it can be useful for recovery and rehabilitation also.

- **Education**

Education implies making people aware and knowledgeable about the occurrence of a disaster and steps to be taken to reduce the risk of disaster. The emphasis of Education in IEC is to address the “why” aspect of the occurrence of the disaster. It helps people to understand the “Do’s & Don’ts” during the disaster and helps in coping

with the situation. Depending on the target groups that are addressed, the mode of educating the human resource differs. From Training, Mock Drills, Evacuation plans, basic & Special health aspects every aspect of being prepared for the Disaster is taught in this phase. Education aims to create a set of informed, alert, and self-reliant communities at the base level. Disaster Education helps in developing knowledge in the long run and various educational institutions like schools and colleges play a vital role in creating awareness. Children in many schools are now familiarised with mock drills, evacuation methods, and disaster management systems and it has been made a part of their education system.

- **Communication**

Communication is the most critical stage of disaster preparedness stage. It deals with the exchange of information between individuals/groups/communities. Communication is the process through which information collected is disseminated to individuals and people are prepared to face the hazard. It is essential during evacuation and rescue and searches operations. Once a disaster strikes, communication becomes the basic support system that facilitates the rescue and rehabilitation process. Different forms of communication are used in today's world. With the growing relevance of IoT, social media has overtaken the role of print media in the exchange of information. Various platforms like television, print, media, social media and radio are used for communication of the same.

The Centre for Disaster preparedness produces IEC material to help people understand the disaster risks and help in mitigating the same. IEC requires the active involvement of NGOs, Government departments & agencies, and people at the local and community level for effective Disaster Risk Reduction.

3.1.6 Disaster Resistant House Construction

Natural disasters such as landslides, floods, cyclones, storm surges have left massive collateral damages. Usually, the buildings that face the maximum damages are houses located in marginalized lands. They can be houses that are both feebly

constructed or without any technical guidance that will be damaged. Even a well-constructed building gets adversely affected due to natural calamities depending on the severity of the calamity that strikes. Most natural hazards cannot be averted, and it is practically impossible to attain a disaster resilient house. But we can mitigate the risk by proper planning, designing, and construction of the houses with proper human intervention. Indigenous knowledge is very instrumental in disaster mitigation. Earthquake-resistant house construction done in Kashmir and Pakistan called Dhajji Dewari incorporated traditional wisdom, technology, and skill that evolved overages and have demonstrated dexterity against the hazard. However modern-day technology is also good enough in constructing houses engineered to be disaster resilient.

Impact of Natural calamities on houses:

- Landslides: the movement caused by the slide may lead to cracks on the houses, tilt the house and even collapse under excessive deformation. The rocks or debris might hit the roofs of the houses and damage them or completely bury them under the debris.
- Floods/cyclones/Tsunami: Seawater inundation can affect the construction of the entire building. The water current might break through the walls and leave a lot of debris within the houses, leading to a collapse of the structure. Masonry used in houses and poorly designed foundations can easily give away during a flood. Houses with lighter structures can even be carried away in a flood when the forces of flowing water are significantly large. Water filled up around the building can exert uplift forces on the floor large enough to cause damage to the floor slab. Moreover, foundations can undergo settlement or total collapse due to loss of strength caused by saturation or liquefaction of subsoil. The excessive winds might blow off the house roofs especially if they are tiled roofs.
- Earthquakes: Ground shaking from earthquakes and secondary effects can damage or destroy a house unless it has been designed and constructed or

strengthened to be earthquake resistant. Houses of traditional construction with brick or stone masonry are the most vulnerable. The fatalities have been maximum due to the collapse of the building

Construction of Disaster Resilient houses:

Residential buildings are composed of structural and non-structural components in which numerous types of material are used. Foundations, columns, beams, walls, floor slabs, and roof frames are the basic structural components that make the skeleton of the structure, which carries the loads and is connected to other members. In a Hazard Resilient House, these components are designed to contribute as much as possible to the integrity of the structure

Based on the published information on disaster-resilient houses in National Building Research Organisation (NBRO), Sri Lanka, 2013, the reinforced concrete frame shall consist of :

- A foundation system that is suitable for the ground conditions and structural loads to be used.
- Reinforced concrete columns are provided at each corner of the house and elsewhere as required.
- Reinforced plinth beams are to be provided at the base of the structure; over the wall, foundations structurally connected with the columns unless the wall foundation itself is of concrete.
- Reinforced concrete tiles at the required levels, structurally tied to the reinforced concrete frames.
- A roof frame for a pitched roof with tiles or sheets or a flat concrete roof slab properly anchored to the superstructure.
- Concrete slab floors were required for the upper floor.

Engineered regular structures with symmetric frames incorporating disaster resilient features are highly encouraged

- It is recommended that the house is planned to be constructed as a reinforced concrete framed structure with masonry walls between columns.

- The reinforced concrete frame shall be of reinforced concrete columns provided at each corner of the house at minimum ties with reinforced concrete beams at required levels.
- The length of the structure is recommended not to exceed three (3) times the width of the structure (length to width ratio to be maximum 3:1).

[Building Codes & Standards](#)

Building codes are guidelines and standards that ensure that minimum safety standards are maintained. Most of the disaster management manuals have suggested that the best tool for increasing the resilience of the building is to ensure that Building codes are followed during the construction alongside Land use planning, emergency management, natural resource protection. It is impossible to build a hundred percent disaster resilient building but through proper standards, it is possible to protect the building against earthquakes of all magnitudes. Minimum strength to withstand minor earthquakes, which occur frequently, with some non-structural damage to resistance to moderate earthquakes, and a withstanding capacity to a major earthquake, which is likely to occur once in a lifetime of the structure, without a complete collapse.

[Recent advances in Housing Technology:](#)

- [Base Isolation Technology](#): This method reduces the forces transmitted to the building from the ground by placing the building atop a mechanical system of isolators, sliders and dampers are called 'base isolation technology'. This dampens the violent movements of the earth during a seismic event. By using isolators and dampers, the building is 'decoupled' from the ground motion of an earthquake, and the transmission of seismic energy to the building is damped. This is done by lowering the vibrational frequency, allowing the building to move or displace. It is also done by lowering the shock acceleration of the seismic event; thus reducing the tendency for the upper floors to move faster than the lower floors.
- [Insulating Concrete Forms \(ICFs\)](#): The houses using Insulating Concrete Forms (ICFs) can resist natural hazards such as hurricanes, earthquakes,

tornadoes, floods, and fires. ICF construction is relatively new to the building codes and home building industry. ICFs are hollow foam blocks or panels that stack and interlock to create exterior walls of a building. Reinforced concrete is then placed inside the foam blocks, creating strong, insulated concrete walls. ICF construction is already noted for benefits such as energy efficiency and durability. But its structural performance when faced with a natural calamity is still in the phase of testing stage.

- **Disaster Resistant Pier Systems:** Another cost-efficient system that is opted for is a disaster-resistant pier system, with stout members rigidly connecting the house's chassis to a slab, grade beam, or array of pads. Some systems incorporate lateral or diagonal bracing for greater resistance. Though often referred to as Earthquake Resistant Bracing (ERB) systems, these also resist high winds, frost heaves, and floods.

3.1.7 Population reduction in vulnerable areas

Changing demographics has increased the vulnerability of the population. If an earthquake hits a region that is sparsely populated, there would be a threat to human life, but the risk is minimal as it is easier to evacuate the people or provide shelter at a safer zone. In case an earthquake of the same magnitude hits an area, which is densely populated, the disaster has a catastrophic impact. This highlights the relationship between population and disaster and how the vulnerability of the people increases due to a higher population in a vulnerable zone. Population growth and distribution especially in the urban areas have led to many man-made disasters like water clogging(Urban floods), overexploitation of water and other natural resources, Soil erosion, and release of toxins into the environment. It is well-accepted fact that population densities and urbanization lead to higher vulnerability of the region. It can be noted that in many countries indiscriminate urbanization and migrations are leading to a denser population in urban/metropolitan areas and India, along with the coastal belts. This has led to dense infrastructure, congestion, fewer escape routes, and income disparity. Denser population in the flood-prone areas which are also highly fertile land has increased the vulnerability. The tsunami of 2004 in the Indian ocean

was an example of how increased human exposure to coastal flooding, hurricanes, and tsunami devastated the lives of millions. The establishment of work, leisure, and travel around the coastal areas resulted in a high fatality rate and collateral damage. Scientists also argue that death and fatalities are high owing to earthquakes in densely populated areas, though the magnitude of the disaster isn't high. The post-disaster challenge also exceeds due to denser populations. Poverty, a fallout of dense population plays a critical role in increasing vulnerability. During disasters like hurricane Katrina, the 2009 Haitian earthquake, it was observed that disasters disproportionately affected an economically weaker segment of the population people. These factors have necessitated the sustainable development goals, investigated the population dimension, and thus reduce the disaster risk.

3.1.8 Awareness

To mitigate the risk of a disaster, being prepared for the same is very essential. Creating public awareness, educating the public, and training them to face natural calamities has been the best non-structural mitigation strategy seen over the years. By knowledge dissemination and discussion about the solutions, we can reduce the vulnerability of an area.

The awareness programs are more effective if they are done at the community level. The aim of creating an awareness program at the local and community level is to see that we have a resilient population that can independently take decisions, use the indigenous knowledge effectively, and is prepared to face the disaster. Following methods can be used to create awareness about disasters:

- Organizing training camps
- Use of street plays/dramas/ songs
- Training in schools & colleges
- Use of print & visual media to create awareness
- Mock drills
- Exhibitions with photos of past disasters and methods of handling the same
- Use of local press to create awareness programs
- Making use of the local NGOs, Self-help groups, etc to create awareness
- Billboards/ warning signs and detailed posters about disaster management

The awareness programs about disaster management should include the following details:

- Details of rescue operations, shelter homes, and rehabilitation centers.
- Important contact numbers of authority to be contacted during the emergency
- Details of availability relief supplies and distribution information about the same
- Details about the course of action to be taken when the disaster strikes
- Details of taking care about the most vulnerable segment of the society like children and aged population
- Clarification regarding myths and rumors and educating people about the same
- Creating awareness about sustainable development and how to reduce man-made disasters

3.2 Emergency Stage (During the Disaster)

The emergency Stage of disaster management is when the disaster strikes a location. The main agenda during this phase is to ensure that people are rescued from the risky situation and that the needs and provisions of victims are met to alleviate and minimize suffering. The thrust areas during this phase would be on elements such as warning, evacuation, search, and rescue operations, assessing the damage, immediate assistance and restoration, and reconstruction. The entire focus during the emergency phase is to maintain the life of the people, providing basic amenities and healthcare facilities and supporting the population that has been impacted by the disaster. The role of the government, local bodies, communities, and humanitarian organizations would be vital during this stage. Maintaining the status quo, trying to rehabilitate people, and venturing into rehabilitation would be the activities that all the organizations would be taking up. Preventing the next disaster from affecting the people while providing necessities would be the secondary objective during the emergency phase.

3.2.1 Rescue Training for search operations at the national & regional level

Search and rescue are the first steps in the emergency stage of disaster management. It is a technical activity that is conducted by a group of trained personnel who will help in rescuing people during the disaster conditions and shall investigate the casualties.

It is a team approach and needs the assistance of people from all the spheres i.e from the national level to the community level. The search and rescue activities are undertaken in three steps:

1. Normal rescue work varied out at the local (village level) by a team of volunteers and trained civil defense.
2. Medium level search by a team of police personnel or block-level
3. Heavy level rescue work that needs the assistance of a team from the state government or armed forces

Major Functions performed by the rescue party:

- To rescue trapped persons from the damaged building, or any other disaster-struck area.
- To provide first aid facilities to the people who are injured
- To see that the damaged buildings are supported without causing any further damage or casualties
- To cut off supplies of water, gas, and electricity from damaged buildings, and
- To recover the dead from the damaged building.

The Search operations are generally done in two stages: Primary & Secondary stage. The Primary search is referred to as a hasty search wherein immediate detection of victims and assessment of the situation is done, followed by preparation of a plan to do an in-depth search. The Secondary search is referred to as the Grid search and it is a well-planned search done with scientific methodology. Here the trapped victims are pinpointed and are rescued without creating any further damage to the infrastructure where they are trapped. A detailed description of the Rescue Stages are as follows

- [Stage-1: Surface Casualty \(Emergency Rescue\)](#)

The main task of the team here is to locate the surface casualty, especially from the outer edge of the damaged areas, and provide basic first aid to the needy. In case of severely injured people, after providing the first aid, they are quickly taken to the nearest medical center.

- [Stage-II: Search in Slightly Damaged Buildings \(Immediate Rescue\)](#)

In stage II, the team move towards the next damaged building on the site after responding to surface casualties. In such cases, assessment of the damaged building before rescue is done is a necessity. The decision of the team leader is extremely important, as the lives safety has to be prioritized, both of the rescuers and the entrapped people

- **Stage-III: Search of Possible Survival Points (Specialized Rescue)**

Stage III requires a specialized team to perform the rescue operations. All possibilities to search for any person being trapped or injured is done at this phase, especially those who are caught under the debris or in any place which cannot be reached by the local team, this specialized task force gets into action. The rescue team should try with all possible means to rescue with the appropriate method considering safety as the top priority.

- **Stage-IV: Selected Debris Clearance (Specialized Rescue)**

The rescue team here will search until all the people are accounted for and identities are ascertained.

- **Stage-V General Debris Clearance (Specialized Rescue)**

Clearing up the debris and reaching the trapped persons, when all possible ways of contacting the trapped persons have failed.

These are the stages in which the Search & rescue operations are performed and in need of coordination and support of people from the local areas, communities, state & national level authorities.

Various types of rescue training that is provided are as follows:

- Flood and Swift water rescue training
- High water evacuation training
- Rescue boat operations training
- Hurricane rescue response
- Ground search & rescue training
- Vertical Rescue Training

Besides basic training is provided to the local teams, which teaches them to perform the primary search along with the use of locally available materials. Basics of using rescue related equipment are also taught to the local community members to be self-resilient to face the disaster.

3.2.2 Immediate Relief

The first response to a disaster often includes search and rescue operations, as well as the provision of immediate relief for those affected in the form of medical care, food and water, and temporary shelter. Depending on the kind and location of the disaster, the organizations that have been earmarked for emergencies must effectively provide initial help. Help may come in form of local, national, or international organizations. Large, international organizations bring supplies and trained personnel from around the world with specialized skills from work in previous disasters. Local, often smaller, agencies bring community knowledge and networks and are often more trusted by those affected. Support for individuals in the aftermath of a disaster is vital. Necessary support includes:

- Temporary shelter
- Clean water
- Food supplies
- Basic sanitation
- Healthcare and supply of medicines along with primary first aid.

The entire focus of the Pre-Preparedness stage of Disaster management gets implemented in this phase. Numerous NGOs help fund these activities that have been mentioned above. Yet, providing direct financial assistance will remain a critical need during the phase. Emergency first responders and non-governmental organizations carry out immediate relief work in the hours, days, and weeks following a disaster. First responders assist with evacuations, initial first aid, clearing and examining structures, and many other activities that allow a community to begin processing a disaster. The entire thrust during this phase of Disaster management is to ensure occupants' safety and well-being and address the immediate threats that loom over the people. Once people are out of the danger zone, then the attention is moved

towards assessment of damage, implementation of disaster response plans, resource distribution and repair, and restoration.

3.2.3 Assessment Surveys

Disaster Assessment refers to, "The survey and information collection activities carried out to determine the effects of a disaster on the victims, the entire community and society". Disaster assessment is seen as an integral part of the response mechanism and is used for future planning. The objective of the assessment is to collect information on the nature of the disaster and its impact and describe how it is affecting the life of the people and their coping mechanisms. The purpose with which assessment is taken up is to provide information that can guide the emergency services and help in search and rescue missions, pinpoint the locations where the disaster has struck, and investigate the nature of the threat by providing information regarding the facilities needed to treat and help the survivors of the disaster. The assessment process must be a continuous one and the situation has to be monitored regularly to focus on the needs of the victims and the supporting entities. The initial assessment would be very preliminary, later it would be followed by an in-depth assessment such as structural survey and hazard mapping -which would provide specific information regarding the reconstruction and mitigation needs.

Stages of Assessment

Disaster assessment can be classified or divided into the following stages:

- Pre-disaster preparedness & planning
- Survey and data collection
- Collation
- Analysis
- Forecasting
- Reporting
- Monitoring

The data that is gathered through the assessment can be classified into hard data - such as the number of people affected, available resources, quantified needs, etc. However, if the need arises the description on the scenario with the background of the

situation by analyzing the socio-economic parameters or political situation which are referred to as soft data.

The method of data collection includes:

- Initial local self-assessment
- Visual inspection
- Sample survey
- Key informant interviews
- Inter-organizational coordination meetings
- Detailed sector analysis by the specialists
- Surveillance Sentinel and polling.

Depending upon the method which is most suitable anyone of these methods can be adopted. Among the above “Survey method”, has been predominantly used for gathering information about the disaster. Teams will be made to go about conducting the survey and a survey- form shall be generated and distributed amongst the people. A first field survey team shall be looking into gathering information regarding the catastrophe that has struck the place. Baseline information required will vary with the location and the nature of the disaster that has struck. Nevertheless, the following information might be included in the survey form

- Geophysical information
- Degree of damage information
- Socio-economic information
- Lifeline's information
- Vulnerability information
- Resource information response standard information
- Contact information

The survey questionnaire that is formulated needs to be checked and validated before it is administered to the people. Due diligence is needed in the selection of the sample (respondents) to whom the question will be distributed.

Types of assessment: There are two types of assessments:

- **Impact assessment:** This examines how the hazard has impacted the community and provides relevant information on the scale and characteristics of the impact.
- **Need assessment:** This deals with the type, amount, and priorities of assistance needed by the affected community after the disaster has struck them. They need assessment after a disaster might include personnel, resource, and equipment requirements

After the disaster has struck a particular location, gathering accurate details & information is essential to enable emergency managers to make quicker decisions on recovery and rehabilitation measures. The details that focus on the need assessments and impact assessment help in better management of the disaster situation and thereby mitigating the Disaster risk.

3.3 Post Disaster Stage

This stage involves the period between the occurrence of the disaster to rehabilitation and reconstruction for normalizing the lives of the people. Activities that restore vital life support systems to normalize operating standards and long-term activities are the area of focus during the post-disaster stage. The problem that is addressed is how we respond, recover, rebuild after a disaster in such a way that there is risk reduction and increased resilience in the society.

3.3.1 Rehabilitation and Reconstruction of disaster-affected areas

Rehabilitation, reconstruction, and sustainable recovery refer to measures that help restore the livelihoods, assets, and production levels of disaster-affected communities. These measures rebuild essential infrastructure, institutions, services and restore the means of production destroyed or made non-operational by a disaster.

The disaster recovery stage in the disaster management cycle falls between the disaster response and overall development phase. It is a vital link between all the 3 stages that have been established in the disaster management cycle. Rehabilitation

and reconstruction are an integral part of disaster recovery. They are a link between disaster response and long-term development.

Rehabilitation:

Rehabilitation involves restoring local services related to the provision of immediate needs. It implies a systematic return to a pre-disaster state. It refers to all the actions taken in the aftermath of a disaster to enable basic services to resume functioning. To assist the victims to repair the physical damage, restore community facilities and revive economic activities and provide support for the psychological and social well-being of the survivors. It focuses on enabling the affected population to resume a normal life. It can be considered as a transitional phase between immediate relief and long-term development.

Reconstruction:

Reconstruction, on the other hand, represents long-term assistance that helps people of the affected area to rebuild their lives and meet their present and future needs. It considers the reduction of future disaster risk. "Build Back Better", is the principle adopted for reconstruction. It may include the replacement of temporary arrangements established as a part of emergency response or the up-gradation of infrastructure and systems from the pre-disaster state. Reconstruction integrates a long-term developmental plan considering future disaster risks and methods to reduce them by incorporating appropriate measures.

Types of Rehabilitation

- **Physical Rehabilitation:** This includes reconstruction of physical infrastructure such as roads, railways, houses, buildings, communication, network, water supply, electricity, etc. It also comprises long-term and short-term strategies towards irrigation, forestry, crop stabilization, employment generation, and environment protection.
- **Social & Economic Rehabilitation:** This is an important part of disaster recovery. It is often assumed to be a community function and neglected in Post – Disaster programs. We understand disasters can render some groups such as elders, orphans, destitute, young children more vulnerable to a disaster due to lack of

support. In the post-disaster phase, family support can break down due to the mental and physical trauma resulting from the loss of life on the property. Thus, these vulnerable groups need special social support to survive the impact of the disaster. Construction of centers meant for day-care, old home age, etc. is to be included as a part of social rehabilitation. A recovery plan should take note of the social dimension of the disaster-affected area. Economic rehabilitation refers to restoring the livelihood of the citizens. Since the disaster can snatch away their livelihood, especially economically weaker segments suffer. Hence the rehabilitation methods help them to seek newer skills to become economically self-reliant or help in the restoration of the damaged sites so that they can get back to their normalized work.

- **Psychological Rehabilitation:** The aftermath of a disaster can be seen in the form of the loss of near and dear ones. The trauma of losing friends family and relatives has an impact upon the psychological wellbeing of the victims. Many NGOs self-help groups in disaster management to provide psychological support programs after a disaster. Apart from physical recovery, psychological recovery also is a requirement. Victims must be helped in dealing with the trauma that they undergo after facing a difficult situation post the disaster.

Guiding principles for Rehabilitation and Reconstruction:

- The Rehabilitation programs should be flexible and encourage adaptiveness.
- The programs must strike a balance between the social, psychological, and economic needs of the community
- The program should focus on assessment of damage, responsibility allocation, and delegation of authority, evaluate, and monitor developmental work continuously.
- The rehabilitation program should also emphasize social, political and economic, and other concerns of the society to facilitate systematic recovery and reconstruction.
- A systematic diagnosis, backed with effective planning and feedback system should be an integral part of the rehabilitation and reconstruction program
- These programs must understand the heterogeneity of the various groups involved and make a future-oriented resilient plan.

3.3.2 Urban Disaster Mitigation

Urban areas have been expanding exponentially in the recent past. It is expected that around 68% of the population of the world would be living in the cities by the year 2050, as per the UN reports. Great human loss, structural damage, and economic upheavals occur due to frequent natural disasters in urban areas. Recognizing the hazards that loom over the urban areas, several risk management projects have been taken.

In the urban areas, to reduce the disaster risk, first, we must understand the location and its exposure to the hazard; followed by an increase in vulnerability due to growing poverty, poor governance, environmental degradation, and over-exploitation of natural resources. The unplanned expansion of cities is increasing to accommodate the rapidly growing population, combined with unscientific use of land and the total failure of urban authorities to implement building standards have led to a rise in the vulnerability of the urban population. Unfortunately, these factors are backed by poor health conditions, illiteracy, poor sanitation system, and malnutrition which has increased the physical and psychological vulnerability of the people living in these areas. The natural disasters compounded by these anthropological activities have increased the risk of these people. Governments across the world, have started working on an urban disaster mitigation plan to reduce the urban disaster risk.

By focusing on urban planning and sustainable development, the governing bodies are aiming at reducing the risk with the help of a strong infrastructure, funding facility. A better understanding of the vulnerabilities is done using a causative approach to recognize the impact of socio-economical changes and various mitigation plans. Though we cannot prevent the occurrence of natural hazards in urban areas, we can reduce the escalation of the same because of anthropological activities. Urban disaster risk mitigation strategies have been focusing on preparing an action plan to reduce the risk of injuries and casualties in the face of a disaster in these urban areas.

Most of the urban areas are prone to many manmade disasters such as

- Waterlogging
- Urban floods

- Urban fires
- Epidemics and pandemic outbreaks
- Emission of toxic wastes and hazardous gases into the environment
- nuclear pollution
- Soil erosion
- Heat effects

By proper risk assessment, and evaluation of existing conditions we can determine the nature and extent of damages. The post-disaster assessments help in identifying the risk factors which further help in making decisions that mitigate the risk. The risk assessment process shall involve analysis and evaluation of data suggesting the location, frequency intensity, physical features, demographic variables, etc. collected based on the survey form and interviews. The collation of these data helps in taking measures to improvise the situation.

Key areas in disaster risk mitigation in an urban setup:

1. Construction

Large-scale construction should be done based on building codes and structural norms which ensure that there is earthquake resistance, fire protection, flood protection, and has safe access to emergency services. A proper structural design and quality control during the construction stage should be made mandatory by a robust and functioning regulation system. Guidelines issued by NIDM must be followed in all parts of the country. Risk can be minimized by various methods such as the adoption of fire detection and safety alert system, automatic water sprinklers, the establishment of fire pumps and fire extinguishers. Prevention of fire accidents at public places slum areas residential buildings and industrial areas is essential making sure that there are proper evacuation and escape routes made available in the building during the time of construction would mitigate the risk. Besides making provision for proper fire safety and fire extinguishing method is done in almost all buildings nowadays unauthorized unsafe electrical connections and storing of hazardous or flammable substances to be governed by the authorities. These structural measures

must be backed with non-structural methods like training, mock drills, and awareness programs about evacuation and exit routes.

2. Climate Change Adaptation.

To reduce the anthropological impact on changing environment, the regulatory bodies have to develop adopt climate-resilient measures. The emphasis has been laid on minimizing the greenhouse gasses effect, energy conservation, afforestation, better sewage and drainage plans, land zoning, and protection. Besides, the city needs to be assessed for capacity, vulnerabilities, and available resources. Climate change has a detrimental impact on the ecosystem and this further is paving way for frequent occurrences of natural disasters. By adopting sustainable developmental goals, we can try to mitigate the risk of climate change. Assessment of groundwater and prevention of overexploitation of the same, using antipollution methods to prevent the emission of toxins into the environment, and trying to control global warming would help in reducing the risk

3. Epidemic Control

An epidemic is a fall after a major disaster if it is not well managed. Especially when the risk of transitivity is intensified, then the epidemic becomes a pandemic, like the covid 19 situation. Hence vaccination drives, maintenance of sanitary arrangements classification of people based on vulnerability are to be investigated to reduce the vulnerability of the urban citizens.

An overall increase in urban resilience, shall decrease the risk and reduce the impact of the hazards. Making available all the emergency relief and measures, proper pre-disaster preparedness will help in mitigating or even averting the urban disaster risk.

4. Institutional & Legislative support system

Local authorities should be allocated sufficient resources especially financial to ensure that there is risk reduction, adequate capacity to monitor compliance with comprehensive rules and regulations. Awareness building programs for public officials' construction experts and communities must be implemented regularly. The local institutions including the municipalities city corporations etc have to be given adequate organizational support to address the consequences of the disaster.

Policymakers generally face numerous challenges concerning urban risk management including lack of adequate knowledge and administrative capacities, weak finances, lack of coordination, poor law enforcement mechanisms, and corruption.

By engaging stakeholders, at all levels, urban disaster mitigation can be done by raising the degree of awareness and developing preparedness and response at the community and administrative levels and also by developing a techno legal regime to enhance the capacities of the urban planning institutions. With all these measures we can ensure sustainability and mitigation of disaster risk

3.3.3 Political and administrative aspects, social aspects, economic aspects, environmental aspects.

All the disasters bring with them a lot of suffering and trauma to the people of the affected area. Often the accelerated, uncontrolled growth of cities has contributed to the ecological transformation and hence has increased the manmade disasters in most of the parts of the world. It has been noticed that poor understanding by decision-makers of disaster-related risk has led to the catastrophic impact of these hazards. Unnatural disasters also have resulted in a large spectrum of epidemics, communal violence, terrorism, nuclear weapon, the use of biological bombs, industrial accidents which have resulted in unhealthy socio-economic and environmental conditions. Climate variation has been seen to be directly correlated to exponential industrialization and exploitation of natural resources. The fall out of these is a drastic increase in Natural disasters and man-induced disasters.

The shock of the disaster usually produces unprecedented human behavior, and the financial impact of these disasters is enormous. The cost of damage is calculated based on the damage of houses, hospitals, factories, infrastructure, and fertile land and crops. Often there would be loss of personal belongings, loss of jobs, government budget deficits, and an increase in the poverty level. The severity of the hazard, the size of the economy, and economic structure decide upon the impact of the disasters. However, poorer countries bear the brunt of both natural & man-made disasters. The extent of damage or vulnerability of a society depends upon socio-economic conditions. It has been observed that though disasters happen uniformly across the

world it is the developing countries that face a larger amount of loss. Wealthier countries can afford to mitigate the risk through sophisticated warning, communication systems, and timely evacuation of people. Unfortunately, this doesn't happen in poorer countries. In developing countries vulnerability increases with growing demographic size and escalated environmental damage. According to world reports, 97% of natural disaster-related deaths take place in developing countries rather than developed countries. In addition to the social losses, there are many examples of disasters destroying the health, sanitation, drinking water facilities housing and developmental areas, and education sectors. The injuries that people face get aggravated because of poor sanitation pollution of water and psychological ill-health cost by the natural disasters. Consequently, socio-economic, and political conditions play a major role in the way disaster mitigation strategies are implemented. This is backed by the political willpower to see that better Pre-disaster strategies are used, and the citizens are well protected.

For effective disaster management, a society that is backed with proper political willpower that focuses on socio-economic balance in the background of sustainable environmental laws is the need of the hour. Disasters disrupt progress and destroy the hard-earned fruits of painstaking developmental efforts, often pushing nations, in the quest for progress, back by several decades. Thus, efficient management of disasters, rather than a mere response to their occurrence has, in recent times, received increased attention both within India and abroad. With the implementation of the Disaster Management Act (2005) and the formation of many centers to handle the crisis, there has been a paradigm shift, from the erstwhile relief-centric response to proactive prevention, mitigation, and preparedness-driven approach for conserving developmental gains and also to minimize losses of life, livelihoods, and property.