UNIT-I

INTRODUCTION

OBJECTIVES:

- To learn about disaster occurrence

SYLLABUS:

Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

Learning Outcomes:

At the end of the lesson, the student will be able to

- explain the concept of disaster of disaster management
- explain different types of disasters.
- explain different disaster mitigating agencies and their organizational structures at different levels

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INTRODUCTION:

India's geo-climatic conditions as well as its high degree of socio-economic vulnerability, makes it one of the most disaster prone country in the world. A disaster is an extreme disruption of the functioning of a society that causes widespread human, material, or environmental losses that exceed the ability of the affected society to cope with its own resources. Disasters are sometimes classified according to whether they are "natural" disasters, or "human-made" disasters. For example, disasters caused by floods, droughts, tidal waves and earth tremors are generally considered "natural disasters." Disasters caused by chemical or industrial accidents, environmental pollution, transport accidents and political unrest are classified as "human-made" or "human- induced" disasters since they are the direct result of human action.

A more modern and social understanding of disasters, however, views this distinction as Artificial since most disasters result from the action or inaction of people and their social and Economic structures. This happens by people living in ways that degrade their environment, Developing and over populating urban centers, or creating and perpetuating social and economic systems. Communities and population settled in areas susceptible to the impact of a raging river or the violent tremors of the earth are placed in situations of high vulnerability because of their socio-economic conditions. This is compounded by every aspect of nature being subject to seasonal, annual and sudden fluctuations and also due to the unpredictability of the timing, frequency and magnitude of occurrence of the disasters.

DISASTER DEFINITION:

A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources

DISASTER MANAGEMENT- DEFINITION.

Can be defined as dealing with and avoiding both natural and manmade disasters.

Disaster management, on the other hand involves:

- Pre-disaster planning, preparedness, monitoring including relief management capability.
- Prediction and early warning damage assessment and relief management.

DISASTER MANAGEMENT- TERMINOLOGY:

Acceptable risk: The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.

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

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.

Climate change: (a) The Inter-governmental Panel on Climate Change (IPCC) defines climate change as: "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in land use". (b) The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Contingency planning: A management process that analyses specific potential events or emerging situations that might threaten society or the environment and establishes arrangements in advance to enable timely, effective and appropriate responses to such events and situations.

Coping capacity: The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.

Critical facilities: The primary physical structures, technical facilities and systems which are socially, economically or operationally essential to the functioning of a society or community, both in routine circumstances and in the extreme circumstances of an emergency.

Disaster risk: The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period. Disaster risk management: The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster risk reduction: The concept and practice of reducing disaster risks through systematic efforts, to analyze 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. Emergency management: The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps.

Emergency services: The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.

Environmental degradation: The reduction of the capacity of the environment to meet social and ecological objectives and needs.

Environmental impact assessment: Process by which the environmental consequences of a proposed project or programme are evaluated, undertaken as an integral part of planning and decision-making processes with a view to limiting or reducing the adverse impacts of the project or progr amme.

Forecast: Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.

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.

Mitigation: The lessening or limitation of the adverse impacts of hazards and related disasters.

Natural hazard: Natural process or phenomenon 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.

Preparedness: The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.

Prevention: The outright avoidance of adverse impacts of hazards and related disasters. Public

A**wareness:** The extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards.

Recovery: The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.

Response: The provision of emergency services and public assistance during or immediately after a disaster in order to save lives reduces health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Retrofitting: Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards.

Risk: The combination of the probability of an event and its negative consequences.

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

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

LEVELS OF DISASTERS

The disaster management and its planning at various tiers must take into account the vulnerability of disaster-affected area, and the capacity of the authorities to deal with the situation. Using this approach, the High Power Committee on Disaster Management5, in its report of 2001, categorized disaster situations into three 'levels': L1, L2, and L3. The period of normalcy, L0, should be utilized for disaster risk reduction.

Level-L1: The level of disaster that can be managed within the capabilities and resources at the District level. However, the state authorities will remain in readiness to provide assistance if needed.

Level-L2: This signifies the disaster situations that require assistance and active mobilization of resources at the state level and deployment of state level agencies for disaster management. The central agencies must remain vigilant for immediate deployment if required by the state.

Level-L3: This corresponds to a nearly catastrophic situation or a very large-scale disaster that overwhelms the State and District authorities.

TYPES OF DISASTERS:

Though, all kinds of disaster require more or less similar skill-sets and rescue-efforts at least a few days after the event, it is important to understand various kinds of disasters. Depending upon the actual nature of disaster, the immediate reaction needs to be different.

Also, the first few moments of disasters are distinctly different for each kind of disasters. Thus, understanding of each kind of disaster might also help in identifying the onset of a disastrous event, so that a trained person can undertake some key actions, during the initial few moments. This could have a major impact on the final outcome in terms of amount of final loss.

Natural disasters:

These are primarily natural events. It is possible that certain human activities could maybe aid in some of these events, but, by and large, these are mostly natural events.

- Earthquakes
- Volcano
- Floods
- Tornadoes, Typhoons, Cyclones

Man Made disasters:

These are mostly caused due to certain human activities. The disasters themselves could be unintentional, but, are caused due to some intentional activity. Most of these (barring coordinated terrorist activities) are due to certain accidents – which could have been prevented – if sufficient precautionary measures were put in place.

- Nuclear Leaks
- Chemical Leaks/Spill over
- Terrorist Activities
- Structural Collapse

DISASTER MANAGEMENT CYCLE:

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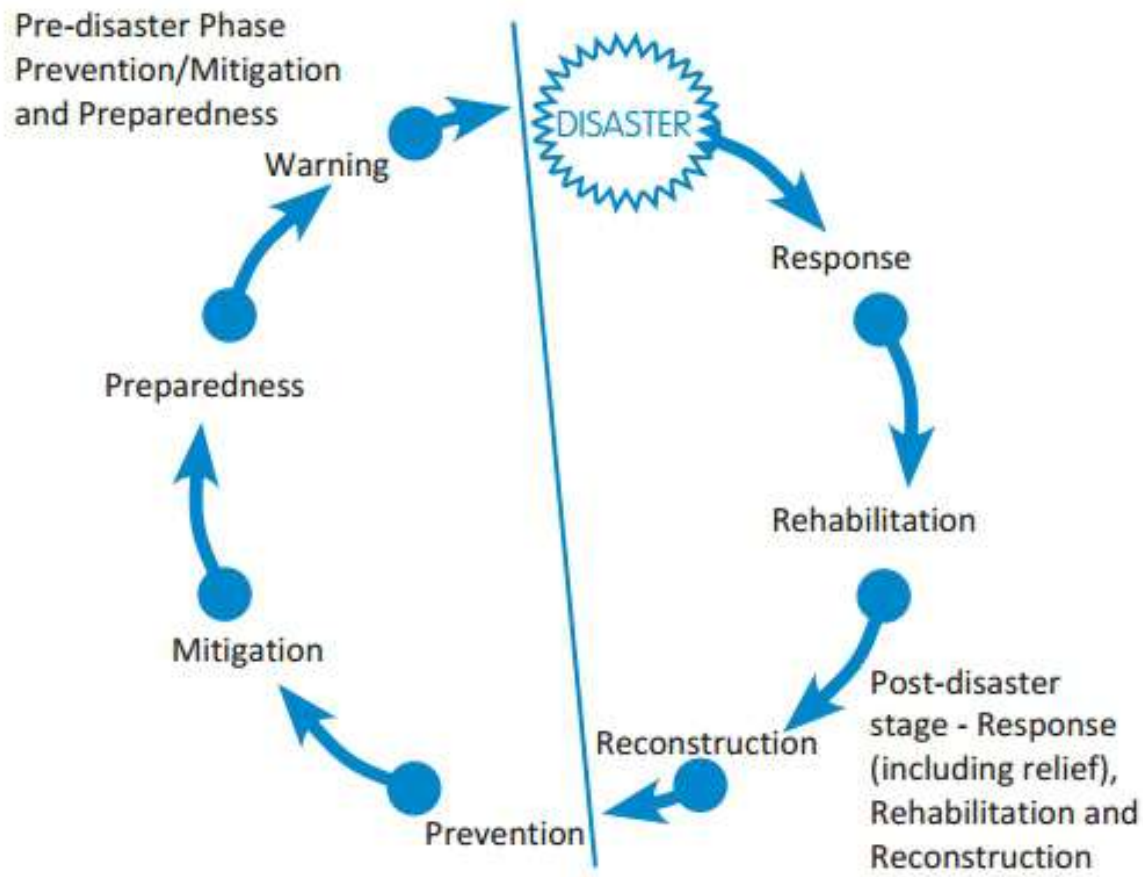


The Disaster Management Cycle consists of mainly two phases.

- Prevention
- Mitigation and Preparedness **Pre-disaster phase**
- Response and Relief
- Rehabilitation and Reconstruction **Post-disaster phase.**

Prevention:

Intention to completely avoid potential adverse impacts through action taken in advance

Example:

Seismic Engineering designs that ensure the survival and function of a critical building in likely earthquake

Mitigation:

Mitigation efforts are attempts to prevent hazards from developing into disasters altogether or to reduce the effects of disasters. The mitigation phase differs from the other phases in that it focuses on long-term measures for reducing or eliminating risk. Mitigation measures can be structural or non-structural. Structural measures use technological solutions like flood levees. Non-structural measures include legislation, land-use planning (e.g. the designation of nonessential land like parks to be used as flood zones), and insurance. Mitigation is the most cost-efficient method for reducing the affect of hazards although not always the most suitable. Mitigation includes providing regulations regarding evacuation, sanctions against those who refuse to obey the regulations (such as mandatory evacuations), and communication of risks to the public.

Preparedness:

Preparedness is a continuous cycle of planning, organizing, training, equipping, exercising, evaluation and improvement activities to ensure effective coordination and the enhancement of capabilities to prevent, protect against, respond to, recover from, and mitigate the effects of natural disasters, acts of terrorism, and other man-made disasters.

In the preparedness phase, emergency managers develop plans of action to manage and counter their risks and take action to build the necessary capabilities needed to implement such plans. Common preparedness measures include:

- Communication plans with easily understandable terminology and methods.
- Proper maintenance and training of emergency services, including mass human resources such as community emergency response teams.
- Development and exercise of emergency population warning methods combined with emergency shelters and evacuation plans.
- stockpiling, inventory, and maintain disaster supplies and equipment[9]
- Develop organizations of trained volunteers among civilian populations. Professional emergency workers are rapidly overwhelmed in mass emergencies so trained, organized, responsible volunteers are extremely valuable. Organizations like Community Emergency Response Teams and the Red Cross are ready sources of trained volunteers. The latter's

emergency management system has gotten high ratings from both California, and the Federal Emergency Management Agency (FEMA).

Response:

The response phase includes the mobilization of the necessary emergency services and first responders in the disaster area. This is likely to include a first wave of core emergency services, such as firefighters, police and ambulance crews. They may be supported by a number of secondary emergency services, such as specialist rescue teams. A well rehearsed emergency plan developed as part of the preparedness phase enables efficient coordination of rescue.

There is a need for both discipline (structure, doctrine, process) and agility (creativity, improvisation, adaptability) in responding to a disaster. Combining that with the need to onboard and build a high functioning leadership team quickly to coordinate and manage efforts as they grow beyond first responders indicates the need for a leader and his or her team to craft and implement a disciplined, iterative set of response plans. This allows the team to move forward with coordinated, disciplined responses that are vaguely right and adapt to new information and changing circumstances along the way.

Recovery (It includes Rehabilitation and Reconstruction):

The aim of the recovery phase is to restore the affected area to its previous state. It differs from the response phase in its focus; recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed. Recovery efforts are primarily concerned with actions that involve rebuilding destroyed property, re-employment, and the repair of other essential infrastructure. Efforts should be made to "build back better," aiming to reduce the pre-disaster risks inherent in the community and infrastructure. An important aspect of effective recovery efforts is taking advantage of a ‘window of opportunity’ for the implementation of mitigative measures that might otherwise be unpopular. Citizens of the affected area are more likely to accept more mitigative changes when a recent disaster is in fresh memory.

NODAL / MITIGATING AGENCIES FOR DISASTER MANAGEMENT:

- Floods : Ministry of Central Water Resources, CWC

- Cyclones : Indian Meteorological Department
- Earthquakes : Indian Meteorological Department
- Epidemics : Ministry of Health and Family Welfare
- Avian Flu: Ministry of Health, Ministry of Environment,
- Ministry of Agriculture and Animal Husbandry
- Chemical Disasters : Ministry of Environment and Forests
- Industrial Disasters : Ministry of Labor
- Rail Accidents : Ministry of Railways
- Air Accidents : Ministry of Civil Aviation
- Fire : Ministry of Home Affairs
- Nuclear Incidents : Department of Atomic Energy
- Mine Disasters : Department of Mines

Table: Nodal Ministry for Management / Mitigation of Different Disasters

S.No	Disaster Nodal Ministry/ Department	Disaster Nodal Ministry/ Department
1	Biological	Ministry of Health and Family Welfare (MoHFW)
2	Chemical and Industrial	Ministry of Environment, Forests and Climate Change (MoEFCC)
3	Civil Aviation Accidents	Ministry of Civil Aviation (MoCA)
4	Cyclone/Tornado	Min. of Earth Sciences (MoES)
5	Tsunami	Min. of Earth Sciences (MoES)
6	Drought/Hailstorm/Cold Wave and Frost/Pest Attack	Min. of Agriculture and Farmers Welfare (MoAFW)
7	Earthquake	Min. of Earth Sciences (MoES)
8	Flood	Min. of Water Resources (MoWR)
9	Forest Fire	Min. of Environment, Forests, and Climate Change (MoEFCC)
10	Landslides	Min. of Mines (MoM)
11	Avalanche	Min. of Defence (MoD)
12	Nuclear and Radiological Emergencies	Dept. of Atomic Energy (DAE)
13	Rail Accidents	Min. of Railways (MoR)
14	Road Accidents	Min. of Road Transport and Highways (MoRTH)
15	Urban Floods	Min. of Urban Development (MoUD)

MITIGATING AGENCIES FOR DISASTER MANAGEMENT IN INDIA:

National Disaster Response Force (NDRF)

The DM Act (Disaster Management Act), 2005 made the statutory provisions for the

constitution of the National Disaster Response Force (NDRF) with the objective of specialized response to natural and man-made disasters. As per the Section 45 of the DM Act 2005, the NDRD has to function under the general superintendence, direction and control of the National Disaster Management Authority (NDMA) and under command and supervision of Director General, NDRF.

NDRF a specialist force, the force is gradually emerging as the most visible and vibrant multi-disciplinary, multi-skilled, high-tech force of the NDMA capable of dealing with all types of natural and man-made disasters.

At present, National Disaster Response Force (NDRF) is about constituted of battalions from the BSF, CRPF, CISF and ITBP

National Disaster Management Authority (NDMA)

The National Disaster Management Authority (NDMA), headed by the Prime Minister of India, is the Apex Body for Disaster Management in India. The setting up of the NDMA and the creation of an enabling environment for institutional mechanisms at the State and District levels is mandated by the Disaster Management Act, 2005.

State Disaster Management Authorities (SDMAs)

Headed by respective Chief Ministers of the States National Disaster Management Authority has been constituted with the Prime Minister of India as its Chairman, a Vice Chairman with the status of Cabinet Minister, and eight members with the status of Ministers of State.

NDMA as the apex body is mandated to lay down the policies, plans and guidelines for Disaster Management to ensure timely and effective response to disasters. Towards this, it has the following responsibilities:-

- Lay down policies on disaster management;
- Approve the National Plan;
- Approve plans prepared by the Ministries or Departments of the Government of India in accordance with the National Plan;
- Lay down guidelines to be followed by the State Authorities in drawing up the State Plan;
- Lay down guidelines to be followed by the different Ministries or Departments of the Government of India for the Purpose of integrating the measures for prevention of disaster or the mitigation of its effects in their development plans and projects;
- Coordinate the enforcement and implementation of the policy and plan for disaster management; Recommend provision of funds for the purpose of mitigation;
- Provide such support to other countries affected by major disasters as may be determined by the Central Government;
- Take such other measures for the prevention of disaster, or the mitigation, or preparedness and capacity building for dealing with the threatening disaster situation or disaster as it may consider necessary;

- Lay down broad policies and guidelines for the functioning of the National Institute of Disaster Management.

National Institute of Disaster Management (NIDM)

The National Institute of Disaster Management (NIDM) was constituted under an Act of Parliament with a vision to play the role of a premier institute for capacity development in India and the region.

Under the Disaster Management Act 2005, NIDM has been assigned nodal responsibilities for human resource development, capacity building, training, research, documentation and policy advocacy in the field of disaster management.

NIDM provides technical support to the state governments through the Disaster Management Centres (DMCs) in the Administrative Training Institutes (ATIs) of the States and Union Territories.

NIDM hosts the SAARC Disaster Management Centre (SDMC) and works as its national focal point.

International Strategy for Disaster Reduction (ISDR)

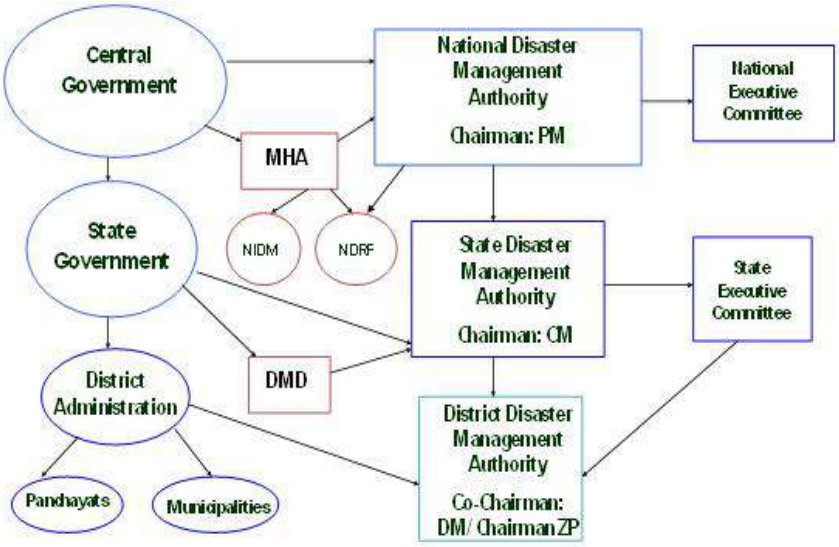
Created in December 1999, UNISDR is the secretariat of the International Strategy for Disaster Reduction (ISDR).

Its core areas of work includes ensuring disaster risk reduction (DRR) is applied to climate change adaptation, increasing investments for DRR, building disaster-resilient cities, schools and hospitals, and strengthening the international system for DRR.

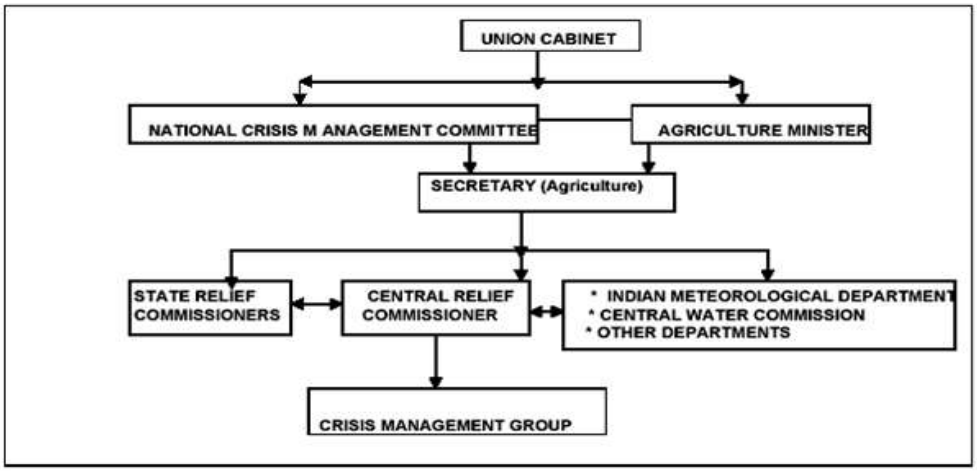
UNISDR's vision is based on the three strategic goals of the Hyogo Framework for Action: integrating DRR into sustainable development policies and planning, developing and strengthening institutions, mechanisms and capacities to build resilience to hazards, and incorporating risk reduction approaches into emergency preparedness, response, and recovery programmes.

The "Hyogo Declaration" and the "Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters" was adopted by the World Conference on Disaster Reduction, held in Kobe, Hyogo, Japan, in January 2005. The Hyogo Framework for Action (HFA) tasked UNISDR with supporting the implementation of the HFA.

Organizational steps for disaster management

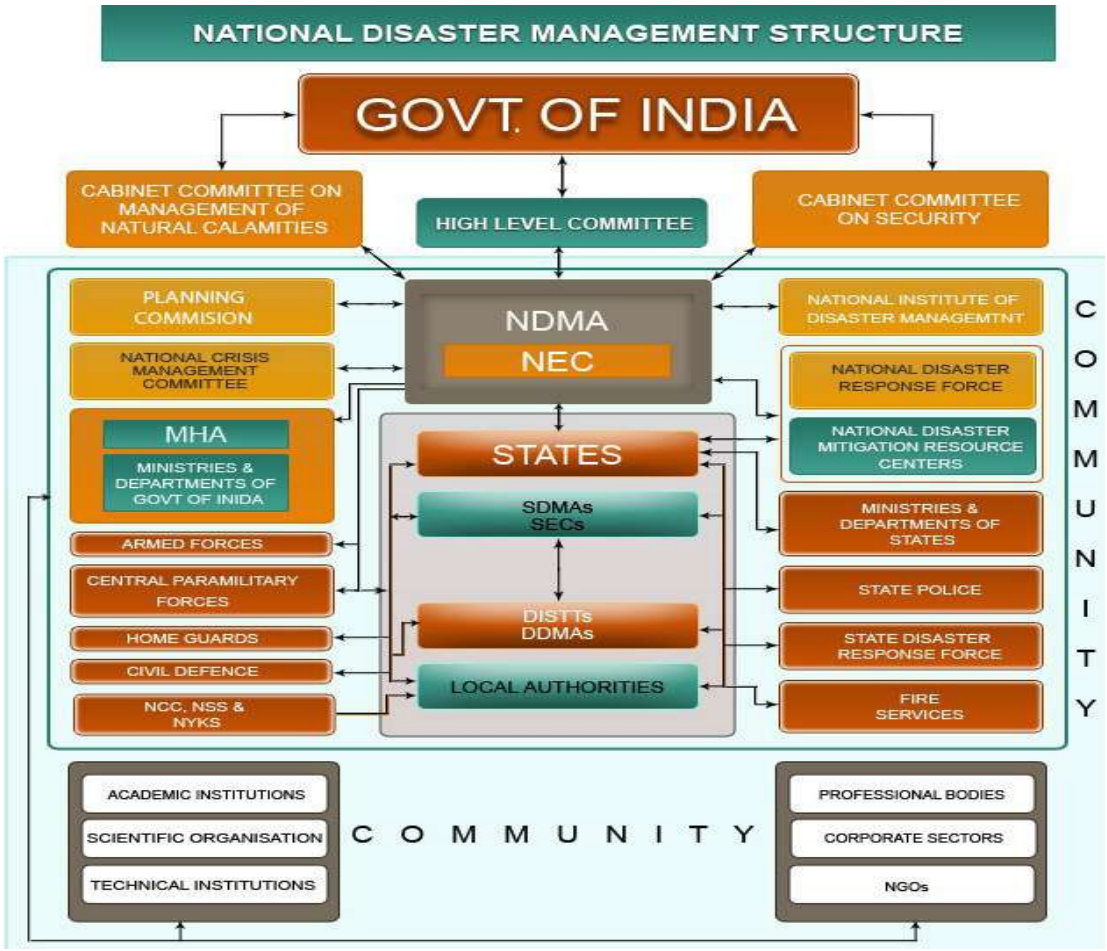


National response mechanism



Natural Disaster Response- Government of India:

- National Crisis Management Committee(NCMC) under Cabinet Secretary
- Crisis Management Group(CMG) under Central Relief Commissioner
- Group of Ministers, Group of Secretaries and High Level Committees-Need base


NATIONAL DISASTER MANAGEMENT STRUCTURE
GOVT. OF INDIA
CABINET COMMITTEE ON MANAGEMENT OF NATURAL CALAMITIES
HIGH LEVEL COMMITTEE
CABINET COMMITTEE ON SECURITY
PLANNING COMMISION
NDMA
NEC
NATIONAL INSTITUTE OF DISASTER MANAGEMTNT
NATIONAL CRISIS MANAGEMENT COMMITTEE
NATIONAL DISASTER RESPONSE FORCE
NATIONAL DISASTER MITIGATION RESOURCE CENTERS
MHA
MINISTRIES & DEPARTMENTS OF GOVT OF INIDA
STATES
SDMAs SECs
MINISTRIES & DEPARTMENTS OF STATES
ARMED FORCES
CENTRAL PARAMILITARY FORCES
STATE POLICE
DISTTs DDMAs
HOME GUARDS
STATE DISASTER RESPONSE FORCE
CIVIL DEFENCE
LOCAL AUTHORITIES
NCC, NSS & NYKS
FIRE SERVICES
COMMUNITY
ACADEMIC INSTITUTIONS
SCIENTIFIC ORGANISATION
TECHNICAL INSTITUTIONS
COMMUNITY
PROFESSIONAL BODIES
CORPORATE SECTORS
NGOs

UNIT-II

OVERVIEW OF DISASTER SITUATIONS IN INDIA

OBJECTIVES:

- To know about Disaster Situations in India

SYLLABUS:

Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India

Learning Outcomes:

At the end of the lesson, the student will be able to

- explain vulnerability profile and mapping of India.
- explain ways and means, skills and strategies of disaster preparedness.
- prepare field report on various important disasters

Vulnerability of profile of India:

India is vulnerable, in varying degrees, to a large number of disasters. More than 58.6 per cent of the landmass is prone to earthquakes of moderate to very high intensity; over 40 million hectares (12%) of its land is prone to floods and river erosion; close to 5,700 kms, out of the 7,516 kms long coastline is prone to cyclones and tsunamis; 68% of its cultivable area is vulnerable to droughts; and, its hilly areas are at risk from landslides and avalanches. Moreover, India is also vulnerable to Chemical, Biological, Radiological and Nuclear (CBRN) emergencies and other man-made disasters.

- India is Vulnerable to wind storms spawned in the Bay of Bengal and the Arabian Sea
- Earthquakes caused by active crustal movement in the Himalayan mountains
- Floods brought by monsoons
- Droughts in the country's arid and semiarid areas

- 57% of the land is vulnerable to earthquake (high seismic zones III–V)
- 68% to drought
- 8% to cyclones
- 12% to floods

Earthquakes

Among the EQ Prone areas

- 12% is prone to very severe earthquakes
- 18% to severe earthquakes and
- 25% to damageable earthquakes
- The Himalayan regions are particularly prone to earthquakes.
- The last two major earthquakes shook Gujarat in January 2001 and Jammu and Kashmir

in October 2005

- All 7 North East states of India –
    - Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya; Andaman & Nicobar Islands;
    - Parts of 6 other states in the North West (Jammu and Kashmir, Uttaranchal, Bihar) and West (Gujarat), are in Seismic Zone V.

FLOODS.

- About 30 million people are affected annually. Floods in the Indo–Gangetic–Brahmaputra plains are annual feature.
- On an average, a few hundred lives are lost, millions are rendered homeless and several hectares of crops are damaged every year.
- Nearly 75% of the total rainfall occurs over a short monsoon season (June – September).
- 40 million hectares, or 12% of Indian land, is considered prone to floods. Floods are a perennial phenomenon in at least 5 states – Assam, Bihar, Orissa , Uttar Pradesh and West Bengal.
- On account of climate change, floods have also occurred in recent years in areas that are normally not flood prone.
- In 2006, drought prone parts of Rajasthan experienced floods.

Droughts

- About 50 million people are affected annually by drought.
- Of 90 million hectares of rain fed areas, about 40 million hectares are prone to insufficient or no rain.
- In India annually 33% area receive rainfall less than 750 mm (low rainfall area) and 35 % area receive between 750 to 1125 mm rainfall Medium rainfall) and only 32% falls in the high rainfall (>1126 mm) zone.

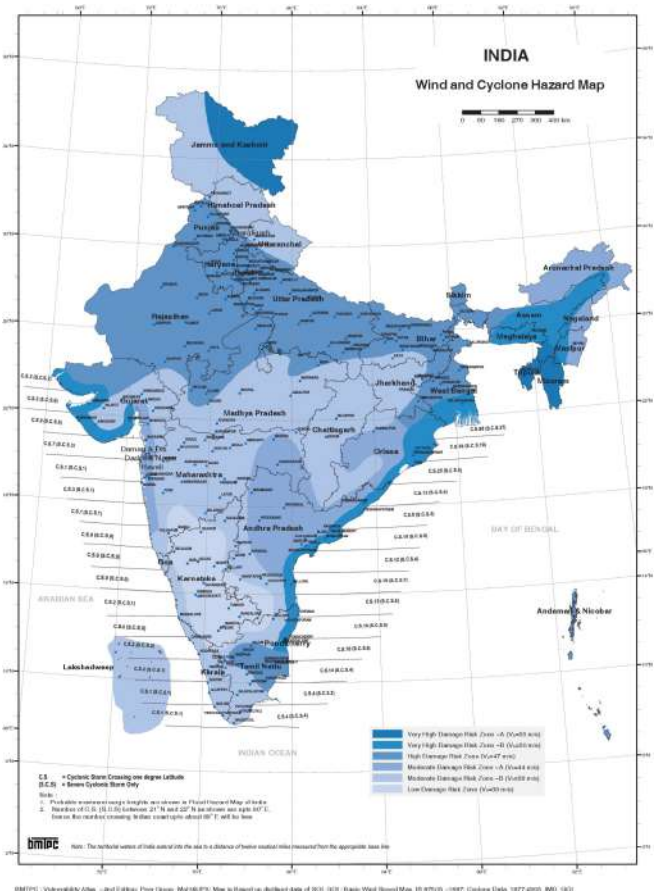
Cyclones:

- About 8% of the land is vulnerable to cyclones of which coastal areas experience two or

three tropical cyclones of varying intensity each year.

- Cyclonic activities on the east coast are more severe than on the west coast.
- Cyclones typically strike the East Coast of India, along the Bay of Bengal, i.e. the states of West Bengal, Orissa, Andhra Pradesh and Tamil Nadu, but also parts of Maharashtra and Gujarat at the Arabian Sea West Coast.
- The Indian continent is considered to be the worst cyclone affected part of the world, as a result of low depth ocean bed topography and coastal configuration.
- The principal threat from a cyclone are in the form of gales and strong winds.

Disaster risks in India are further compounded by increasing vulnerabilities related to changing demographics and socio-economic conditions, unplanned urbanization, development within high-risk zones, environmental degradation, climate change, geological hazards, epidemics and pandemics. Clearly, all these contribute to a situation where disasters seriously threaten India's economy, its population and sustainable development. .



VULNERABILITY MAPPING

The vulnerability maps provide information that can lead to disaster impact reduction through safety and environmentally conscious land use management. Local authorities and planners can use the information to complement and improve their land use policies and practices and consider the vulnerability of areas such as coastal zones or locations with a high number of residents or tourists.

What is a vulnerability map?

A vulnerability map gives the precise location of sites where people, the natural environment or property are at risk due to a potentially catastrophic event that could result in death, injury, pollution or other destruction. Such maps are made in conjunction with information about different types of risks. A vulnerability map can show the housing areas that are vulnerable to a chemical spill at a nearly factory. But it just as likely, could delineate the commercial, tourist, and residential zones that would be damaged in case of a 100-year flood or, more devastation, a tsunami. Vulnerability maps are most often created with the assistance of computer technology called geographic information systems (GIS) and digital land survey equipment designed for use in the field. However, vulnerability maps can also be created manually using background maps such as satellite imagery, property boundaries, road maps, or topographic maps. In such cases the municipality's planning office should be involved in order to take advantage of the base maps that have already been made for other purposes.

Benefits of vulnerability mapping

Vulnerability mapping can allow for improved communication about risks and what is threatened. It allows for better visual presentations and understanding of the risks and vulnerabilities so that decision -makers can see where resources are needed for protection of these areas. The vulnerability maps will allow them to decide on mitigating measures to prevent or reduce loss of life, injury and environmental consequences before a disaster occurs. An interdisciplinary risk group considers where mitigating measures should be taken before, for

example, a flood occurs. Those preparing the maps can overlap flood inundation and slope stability zones with property maps in order to determine which properties and buildings are at risk. They can then notify the landowners and inform them of government subsidies or other support available for undertaking a measure that would protect their homes from potential damage by, for example, water inundation or slope failure. Vulnerability maps can be of use in all phases of disaster management: Prevention, mitigation, preparedness, operations, relief, recovery and lessons-learned. In the prevention stage planners can use vulnerability maps to avoid high risk zones when developing areas for housing, commercial or industrial use. Technical experts can be alerted about places where the infrastructure can be affected in case of a disaster. Fire departments can plan for rescues before a potentially dangerous event is at hand. During an exercise where a predetermined scenario takes place, the rescue crews may use the map to determine where to respond first to save human lives, the environment or property. They can also be used to evacuation routes to test the effectiveness of these routes for saving large numbers of residents and tourists and moving special groups such as senior citizens, children and those with handicaps. The operations officer can be updated about the disaster situation and the need for and the location of sensitive areas. The vulnerability map can also include evacuation routes to test their effectiveness for saving lives.

After the disaster the vulnerability map and a new map showing the extent of the damage, can assist in assessing how well the emergency was managed. During a post disaster review, the consequences of the disaster can be easily assessed with the help of field data. The evaluators can see if an accurate assessment of vulnerable areas was made and if they were adequately protected. It will also be apparent how effective the mitigation measures were.

Planning the vulnerability map:

Collecting information for a vulnerability map:

As with any risk management endeavor, a group of experts that are familiar with the risks are an asset for creating a vulnerability map. Working together in an interdisciplinary risk group, will provide comprehensive information about risks and vulnerable sites. The members of the group

will increase their knowledge about hazards and the type and extent of disasters that can be expected. Risk groups are most effective when they include an assortment of experts at the municipal level. The group preparing the vulnerability map needs to select those risks that are found in the area to be mapped and decide which risks will be addressed.

Natural risks which can cause disasters include:

- seismic activity
- landslide / slope failure
- avalanche
- volcanic eruption
- windstorm, cyclone, tornado, typhoon,
- snowstorm
- flood
- excessive precipitation, flash floods
- tsunami
- extreme frost, blizzard
- extreme drought
- wildfire

Human-caused hazards or threats include:

- industrial activities
- commercial activities
- traffic and transport on land, sea or air
- sabotage
- terrorist attack
- arson

Once the risks have been selected, the group then discusses types of scenarios where one of these risks becomes an actual event. The scenarios will describe the date, the day of the week, the time of day, the intensity of the event, the weather conditions, season etc. in order to determine an adequate picture of how the natural or human-caused event will take shape and what will be affected by its impact at the particular time and place that it occurs. A cyclone with a certain

speed can hit a particular area with specified impact. A domino-effect scenario can also be written for an event when one of these risks, a natural event or human-caused, can trigger another making the disaster even more devastating. A major flood might be severe enough to encroach upon developed areas. An industrial storage tank containing dangerous goods could be damaged by the rushing waters, causing chemicals to spill into the environment.

Whatever the scenario will be, it needs to be written with enough detailed to provide information about the boundaries of the risk zones. Risk zones should be estimated with the best available knowledge and techniques. With expert help, more accurate risk zones can be calculated for high tides, floods, tsunamis, landslides etc.

The next stage is to determine the objects within the risk zones that will be considered vulnerable and therefore, will be mapped. Vulnerable sites are those where people live, work and visit. They can also be areas where farming, forestry, grazing or industry prevail. Or they can be sites that are difficult to replace or rebuild or which possess historical or cultural values. Habitats with biodiversity or with rare or endemic species preferably require environmental protection. Some sites determined to be high priority for protection, can be classified as such based on the consequences that can incur during or after en unwelcome event.

The baseline data collected for the vulnerability map should be the basis for decisions taken about where prevention and mitigation work needs to be accomplished. Here is an example checklist of objects that could be threatened by a risk. The user can fill in the municipal or regional office that could take responsibility for locating the threatened objects to be mapped.

The office responsible for determining what is vulnerable may vary depending on how the municipal offices are organised. Such offices can be an environmental protection office, technical office, planning office, health care services, education department, culture and recreation department, social services department, agricultural department, forestry department, fire and rescue service department or police station.

Some buildings and facilities require special rescue techniques and can be classified as such on the vulnerability map in order to reduce loss of life when a disaster occurs.

Some examples are:

- High risk buildings
- Compound buildings
- Hotels or other buildings with large numbers of visitors

- Senior citizen retirement homes
- Homes with handicapped residents
- Developed areas where the building materials used such as wood or concrete make them especially sensitive to, for example, fires or earthquakes
- Fishing boats, recreational boats, tankers in the harbour
- Underground installations (such as subways, utility cables)
- Mines

Industries can be broken into different categories such as:

- Petroleum refinery
- Chemical plant
- Plastic, rubber or paint factory
- Steel mill
- Saw mill, paper mill
- Explosives factory

Power generating plants can also be mapped as a separate category.

- Electric or hydroelectric power plants
- Nuclear power plants

When the map is complete, there will be sufficient information to begin discussions about action plans for the threatened objects such as:

1) How will the sites be protected?
2) In which order will they be protected?
3) Who will accomplish the mitigation work?
4) Who will check to see if the mitigation work is adequate?
5) How will the vulnerable sites be addressed in the emergency preparedness plan?

The vulnerability map can be used to decide where appropriate mitigation measures can be taken such as:

- Construction of groynes and sea walls to prevent beach erosion or damage to fishing boats and structures near the coast
- Protecting buildings from high water with sand bags or metal planks
- Stabilising slopes with rods or by reshaping it by mechanical means
- Coastal embankments to protect roads
- Riverbanks and canals can be widened and strengthened
- Protecting a harbour by building dykes Statistical data and methods are used for calculating the strength of, for example, tide water to determine how strong sea walls shall be. Another mitigation measure is relocating threatened objects. If a lowland area is susceptible to regular flooding, new buildings can be constructed in elevated areas outside the floodplain's risk zone.

Seismic Zone Map of India: -2002

About 59 percent of the land area of India is liable to seismic hazard damage

Zone	Intensity
Zone V	Very High Risk Zone Area liable to shaking Intensity IX (and above)
Zone IV	High Risk Zone Intensity VIII
Zone III	Moderate Risk Zone Intensity VII
Zone II	Low Risk Zone VI (and lower)

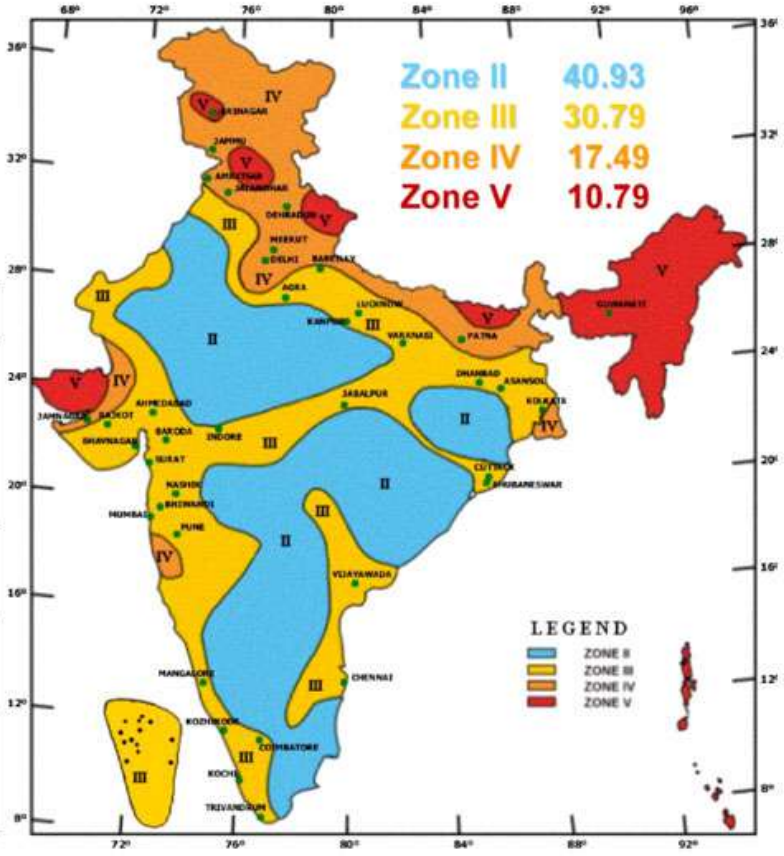
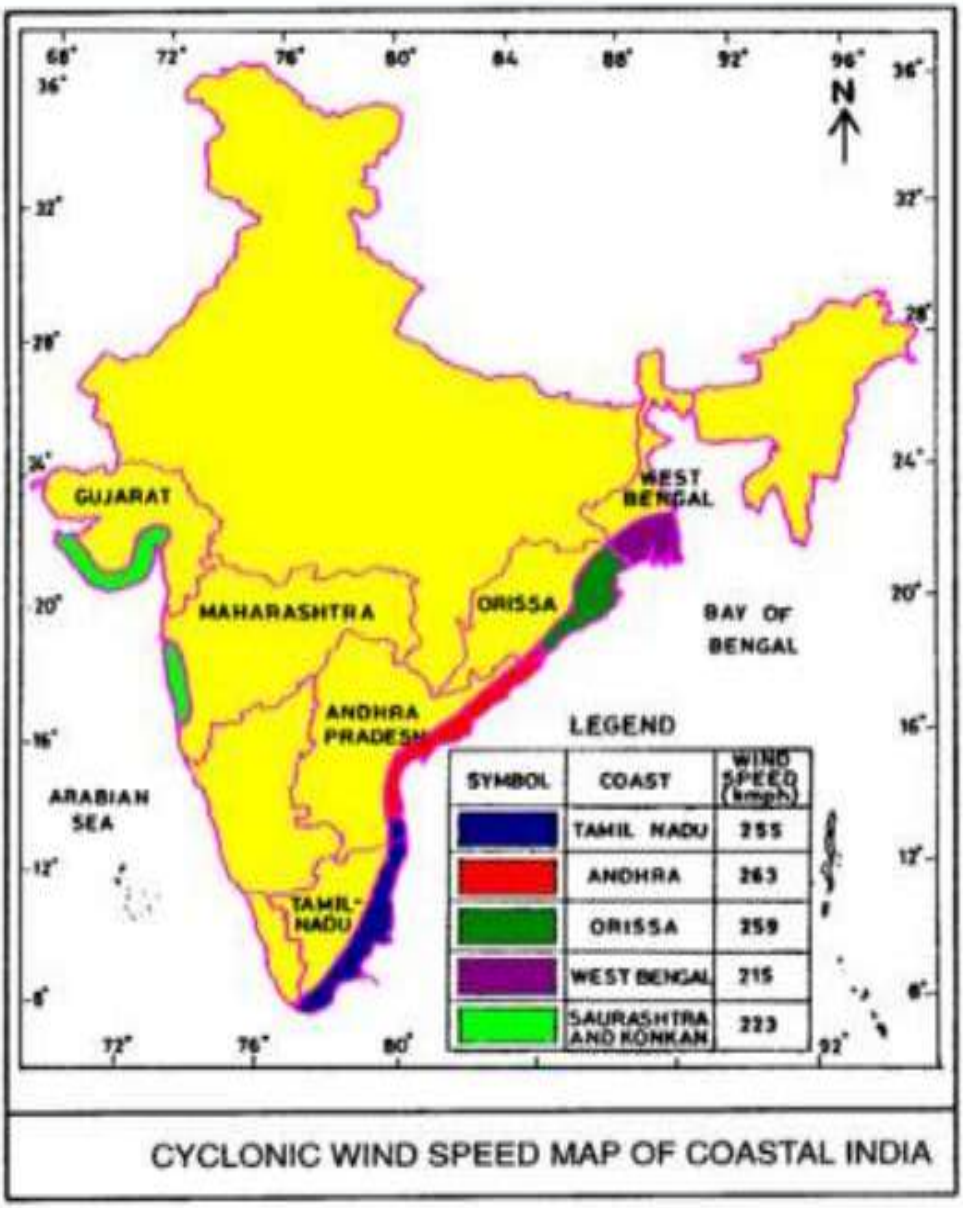
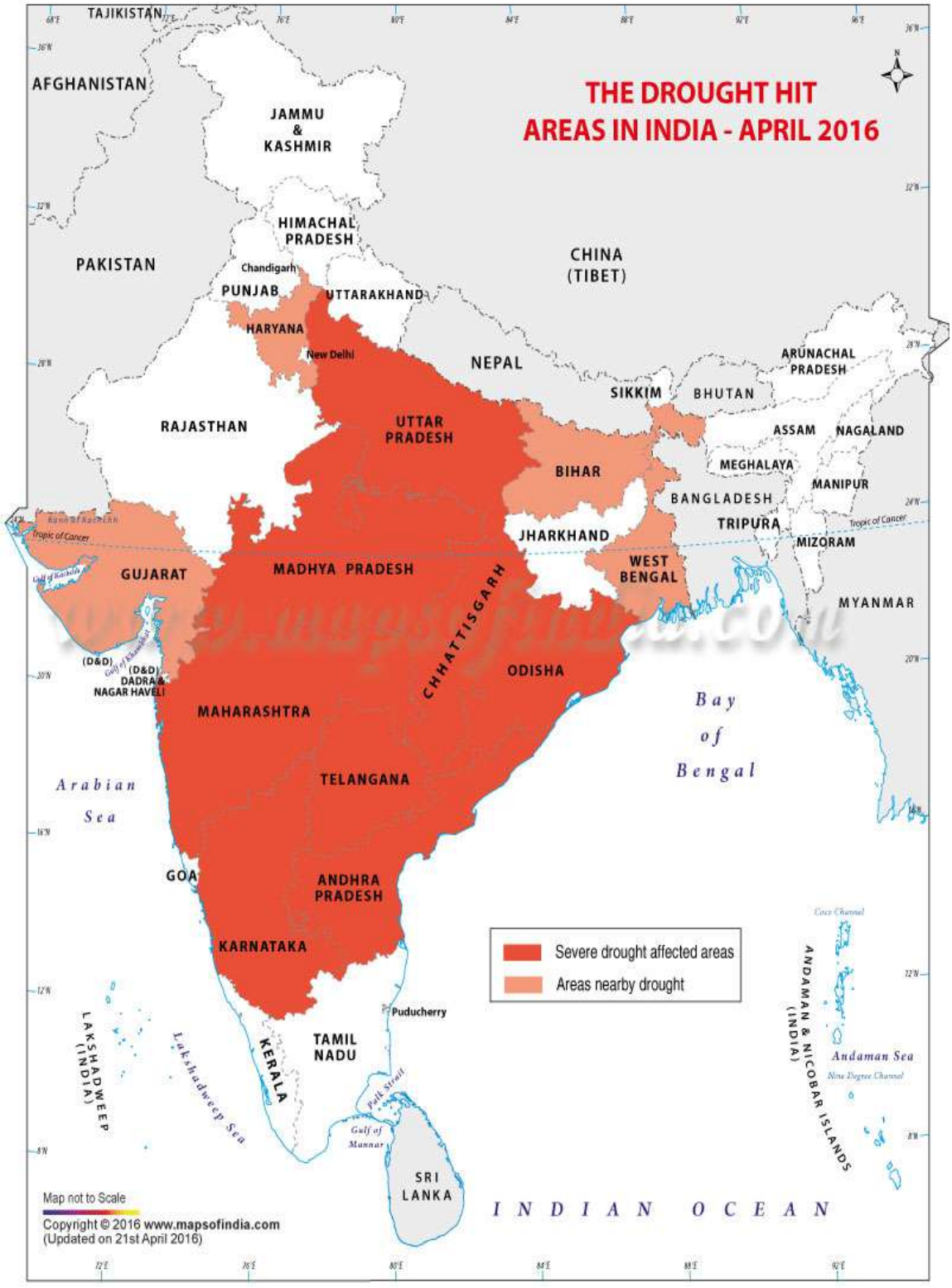


Fig. 1 Seismic zonation and intensity map of India

Cyclone Map of India



CYCLONIC WIND SPEED MAP OF COASTAL INDIA


THE DROUGHT HIT AREAS IN INDIA - APRIL 2016
TAJIKISTAN
AFGHANISTAN
PAKISTAN
JAMMU & KASHMIR
HIMACHAL PRADESH
Chandigarh
PUNJAB
UTTARAKHAND
HARYANA
New Delhi
CHINA (TIBET)
NEPAL
SIKKIM
BHUTAN
ARUNACHAL PRADESH
ASSAM
NAGALAND
MEGHALAYA
MANIPUR
TRIPURA
MIZORAM
BANGLADESH
MYANMAR
RAJASTHAN
UTTAR PRADESH
BIHAR
JHARKHAND
WEST BENGAL
GUJARAT
MADHYA PRADESH
CHHATTISGARH
ODISHA
MAHARASHTRA
(D&D) DADRA & NAGAR HAVELI
TELANGANA
ANDHRA PRADESH
GOA
KARNATAKA
KERALA
TAMIL NADU
Puducherry
LAKSHADWEEP (INDIA)
ANDAMAN & NICOBAR ISLANDS (INDIA)
SRI LANKA
Tropic of Cancer
Arabian Sea
Bay of Bengal
Lakshadweep Sea
Gulf of Mannar
Palk Strait
Andaman Sea
Coco Channel
Nine Degree Channel
INDIAN OCEAN
Severe drought affected areas
Areas nearby drought
Map not to Scale
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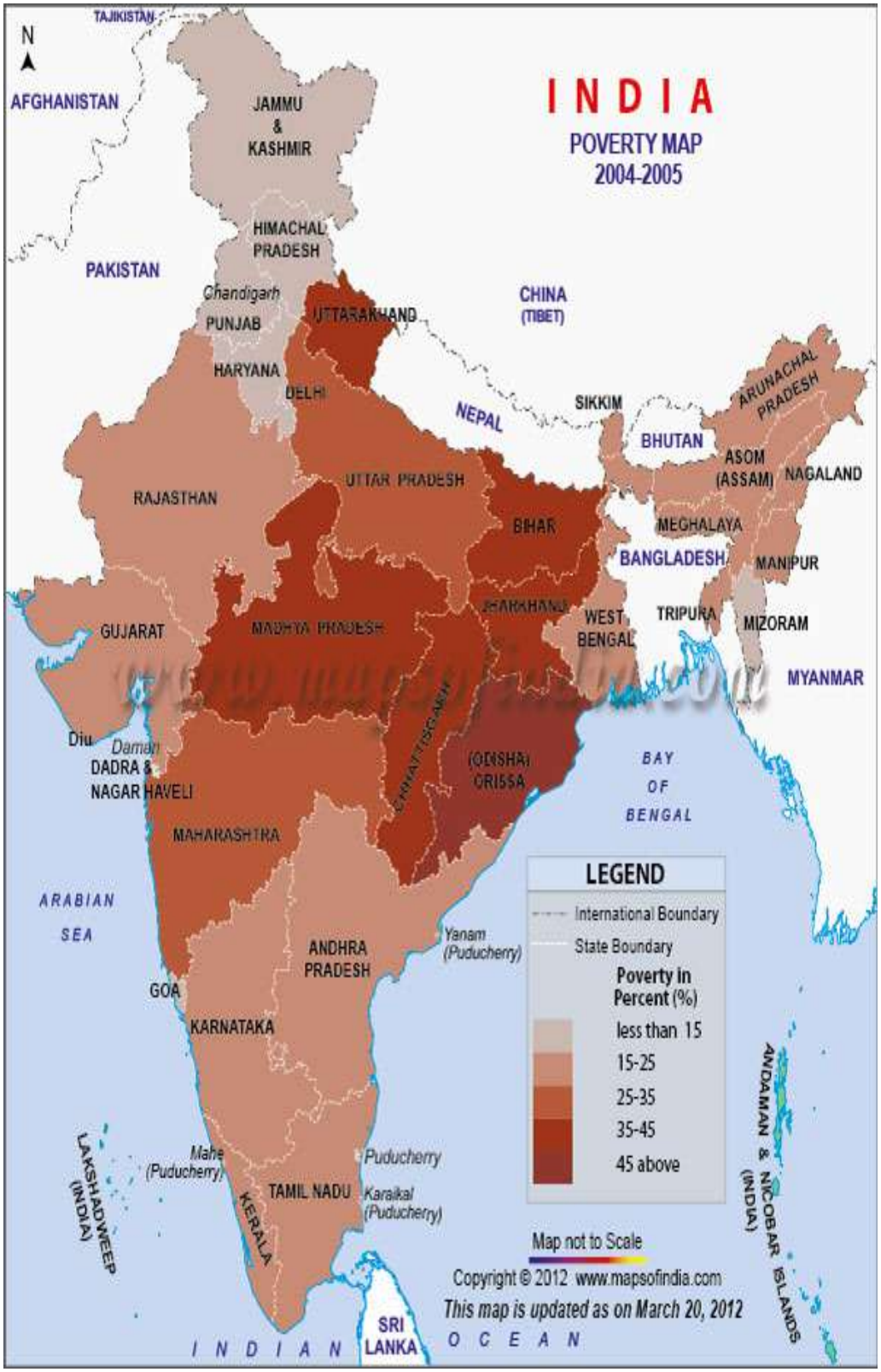
(Updated on 21st April 2016)


INDIA
POVERTY MAP
2004-2005
N
TAJIKISTAN
AFGHANISTAN
PAKISTAN
CHINA
(TIBET)
NEPAL
BHUTAN
SIKKIM
BANGLADESH
MYANMAR
JAMMU & KASHMIR
HIMACHAL PRADESH
Chandigarh
PUNJAB
UTTARAKHAND
HARYANA
DELHI
RAJASTHAN
UTTAR PRADESH
BIHAR
JHARKHAND
WEST BENGAL
ARUNACHAL PRADESH
ASOM (ASSAM)
NAGALAND
MEGHALAYA
MANIPUR
TRIPURA
MIZORAM
GUJARAT
MADHYA PRADESH
CHHATTISGARH
(ODISHA) ORISSA
Diu
Daman
DADRA & NAGAR HAVELI
MAHARASHTRA
BAY OF BENGAL
ARABIAN SEA
ANDHRA PRADESH
Yanam (Puducherry)
GOA
KARNATAKA
TAMIL NADU
KERALA
Mahe (Puducherry)
Puducherry
Karaikal (Puducherry)
LAKSHADWEEP (INDIA)
ANDAMAN & NICOBAR ISLANDS (INDIA)
SRI LANKA
INDIAN OCEAN
LEGEND
International Boundary
State Boundary
Poverty in Percent (%)
less than 15
15-25
25-35
35-45
45 above
Map not to Scale
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This map is updated as on March 20, 2012

DISASTER PREPAREDNESS

All those activities that are intended to be prepared once a disastrous event is going to happen, so that the people can evacuated, protected and rescued as soon as possible.

It involves the following activities:

- Preparation of disaster plan
- Anticipating damage to critical facilities
- Damage inspection, repair and recovery procedure
- Communication and control centers
- Disaster training exercises
- Prepare evacuation plans
- Informing/training population
- Forecasts/warnings/prediction of disaster.
- Monitoring

Preparation of disaster plan:

Coordination with all emerging services, governmental organizations and the public. Establishing an organization for emerging operations

Anticipating damage to critical facilities:

Damage to roads, railway tracks, hospitals, buildings of emergency organizations etc is anticipated and the consequences evaluated.

Damage inspection, repair and recovery procedure:

Setting up procedures for post-disaster damage inspection, trained personnel availability, supply of materials to be used in emergency situations.

Communication and control centers:

Establish procedures for communication during and after the disaster with all emergency services press and government. Setting up a disaster coordination command center

Disaster training exercises:

Training of personnel of disaster emergency services. Announcement of disaster plan with all people involved.

Prepare evacuation plans:

Establishing safe sites for disaster shelters, evacuation routes and the preparation of evacuation maps and close cooperation with the local population.

Informing/training population:

Public information and education on hazards and risks in the areas, information about how to prepare for a disaster and how to react when it happened, informing on evacuation procedures.

Forecasts/Warning/prediction of disasters:

Establishing a natural hazards observatory a technical centre receiving all kinds of scientific data, task of real time data processing and give forecasts and status reports on disasters to emergency organization and public

Monitoring:

Evaluating the developments through time of disasters.

Ex: Flood monitor

DISASTER RELIEF

- Rapid Damage Assessment
- Implementation of Disaster Response Plan
- Establish communication & Infrastructure
- Search & Rescue Operations
- Evacuation, setting up shelters.
- Food & Medical Supply, Disease Prevention.
- Maintaining Public Order.
- Mass Media Coverage
- Co-ordination of international Aid.

Rapid Damage Assessment

Assessment of the severity immediately after the occurrence of a disaster, identify further threats to survivors, followed by detailed damage to buildings will be surveyed.

Implementation of Disaster Response Plan

Starting the disaster coordination and command centre, contact and meet with all emergency organizations**.**

Evacuation, setting up shelters.

Evacuation on the basis of evacuation plan, and the current disaster situation, operation of shelters, storage of salvaged properties.

Food & Medical Supply, Disease Prevention

Providing food rations, assuring water supply and sanitation in shelters.

Maintaining Public Order

Avoiding of looting identify fake-victims from other parts.

Mass Media Coverage

Arranging logistic for visiting reporters, organizations of press conferences, avoiding of biased news coverage**.**

Co-ordination of international Aid.

The international financial assistance to the victims and coordination of scientific aid missions**.**

DISATER REHABILITAION

- Repair/ Demolition of Structures
- Defining areas of construction.
- Reconstruction planning.
- Improve Disaster Management Plan

Repair/ Demolition of Structures

- Based on detailed damage census, structural engineers will decide which of the buildings can be repaired, and which one will have to be demolished.

Defining areas of reconstruction

- The areas that have been severely affected by the disaster should be evaluated in detail, to establish the reasons for destruction.

Reconstruction planning.

- Obtaining necessary funds for the reconstruction of the area, return of survivors to the area, planning and construction of improved buildings and infrastructure.

Improve Disaster Management Plan.

- Re-definition of hazard and risk maps; redefinition of building standards. The reconstruction phase also involves an important aspect of evaluation. The disaster mitigation, preparedness and relief activities should be critically reviewed.

DISASTER MANAGEMENT

(III B.Tech. II sem –Open elective)

UNIT-III

OBJECTIVES:

- To learn about flood and drought disaster occurrence and remedial measures.

SYLLABUS:

Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options, Drought and development, relief management and prevention, drought mitigation and management- integrating technology and people.

Learning Outcomes:

At the end of the lesson, the student will be able to

- Assess flood risk, flood hazard , flood impact
- Explain flood risk reduction options
- Drought mitigation and management

RAISING FLOOD DAMAGE:

The trend of increasing economic impact of natural disasters, and in particular flood disasters, has continued during the past five decades. The international federation of red cross and red crescent societies, for instance, keep records of the type and number of reported disasters, the number of people reported killed and affected by disasters, and damage estimates country wise The Economic losses from major weather disasters, including among others extreme flooding, and raising, at a steadily increasing rate since the second half of the 1980s,reaching an all-year high in 2005,mainly due to the hurricane season in the USA and central America. Global estimates indicate that since the turn of the millennium about 40,000 people lost their lives from river line flooding and some 800 million people were effected, loosing property and livelihoods, having to leave their homes and live in emergency shelters, or being trapped in flooded areas.

There is a rising concern that worldwide, damage resulting from water-related disasters is growing dis-proportionately. Even if one makes allowance for population growth,

economic progress and development in general, there is widespread expectation that technological and scientific advances should ensure greater protection against impact of these disasters than in the past. Two trends point to an increased flood risk and to greater economic flood damage from floods around the world. First, the frequency of major floods appears to be increasing as a result of climate change and inappropriate development practices. Second, there has been a marked increase in vulnerability in flood-prone areas due to the increase in the number of people and economic assets located there.

The poor and developing countries are evidently hit the hardest, both in no. of affected people and in the economic impact on national economies. The available limited resources in less developed countries, that could be invested I development, have to be delivered to flood relief, rehabilitation and recovery. Affluent people and economies can also be severely impacted.

ASSESSING FLOOD RISKS:

The first step in flood risk management is assessing risks associated with such events. The major parameters of assessment are discussed in the following section.

Understanding Flood Risks:

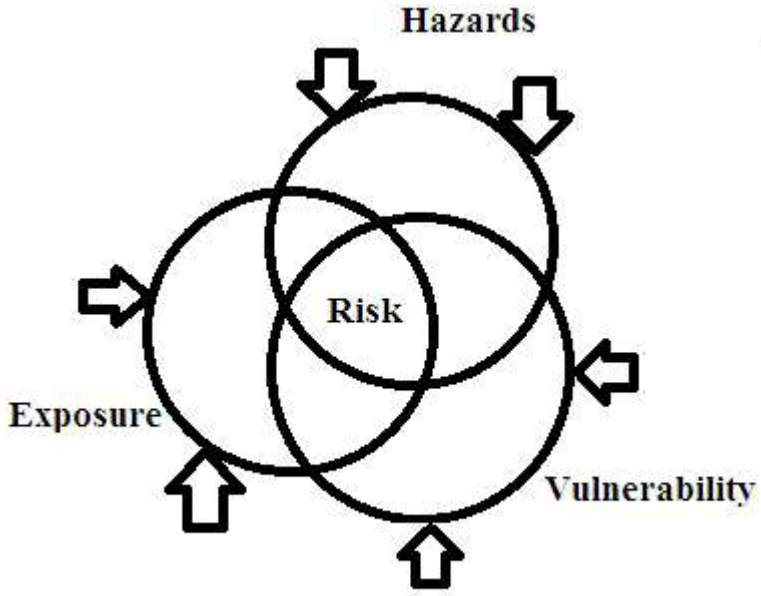
A proactive approach to flood risk management requires identification of present and future risks, creation of policies based on the awareness of such risks and managing these risks.

For the risk assessment, a quantitative approach has been used. However, there is a significant judgmental aspect to estimating several of the input parameters for the numerical model. At the same time, assessment of the risk is influenced by the perceptions about the risk.

Strictly speaking, this means assessment is at the best only semi-quantitative. However, professional judgment and experience are the valid and accepted means of developing realistic models of complex natural or human behavioral mechanisms.

The mathematical definition of the risk is the probability of harmful consequences, or expected loss resulting from interaction between hazards and is expressed by the equation:

This definition incorporates exposure to the hazard as part of the vulnerability. Such a definition has resulted in focusing on reducing exposure through engineering measures alone, precluding adequate attention to tackling the socio economic vulnerability while looking for options for flood risk reduction. Problem analysis starts with understanding the construction of flood risks (fig.)



Flood risks therefore should be understood as a function of the:

- *Magnitude* of the flood hazard expressed in terms of frequency and severity
- *Exposure* of human activities to flooding (depth, extent and duration of inundation and relative velocities),
- *Vulnerability* of the elements at risk.

As pointed out above, unlike other risks it is important to distinguish the vulnerability due to the physical circumstances and that due to the socio economic conditions as the two have to be addressed simultaneously but through different development processes.

FLOOD HAZARD ASSESSMENT:

Flood hazard assessment starts with the identification of the sources of flood hazard followed by measuring the physical level of peril at a particular location and the associated probability of their intensities. Each of the causes of flooding has to be assessed based on the hydrological processes that govern the flooding. Well developed and tested scientific methods are used for hazard assessment. They involve various steps such as data collection and analysis, and hydrological and hydrodynamic modeling. Identification of flood hazards is often carried out in the conjunction with other related hazards such as mud flows, debris flows and landslides in order to produce multi hazard maps and management programs, essentially taking the river basin as the until for assessment.

Hazard assessment is presented in the form of flood hazard maps, which are tools that help to organize and present the information for use by decision makers and the public. A variety of terms are used in connection with flood maps. Flood risk maps were the commonly used terms in the 1970s and 80s.Terms like flood inundation maps, flood zoning maps, flood escape route maps, flood planning maps, flood vulnerability maps, and flood intensity maps have also been used in the literature but without clear distinction. However the overall objective of flood maps can be stated as: "to provide information on the past, likely or potential extent of flooding and its impacts which help in making decisions on various aspects of flood management.

Nomenclature of the flood maps should depend on the use to which they are likely to be put and the information that is provided there in. In addition to their general objective of a flood map, special uses like tools for evacuation routes, which may be of utmost importance in cases of tsunamis and floods in large flat lands require related supplementary information. Some other functions of flood maps would be:

Regulatory: Land use regulation and building codes.

- *Spatial planning*: Impacts of urbanization, other land uses and climate change.
- *Rescue operations*: Building shelters and earmarking escape routes,
- *Informational/Educational*: Record of flood magnitude in an area,
- Flood insurance,
- Vulnerability index.

FLOOD IMPACT ASSESSMENT:

Impact assessment is an important and integral part of risk and management. An understanding of the impact of an event is required in assessing the benefit/cost ratio of various options of risk management strategies.

Different methods to assess potential impacts are used depending on the type of impacts to be assessed. For example, assessing the impact on environment requires a different approach as compared to assessing the impacts on human habitat, industry, agriculture and infra structure as well as possible fatalities. Impact assessment will also vary depending on the data availability, social settings and the economic situation.

In this content, flood loss estimation becomes a vital element in assessing the relative merits of various options. Assessing potential flood losses is inevitable when policy makers and planners try to strike an optimal balance between the development needs of a particular area and the level of flood risk community is ready to accept. Estimation of potential losses have to be made for the life time of a particular mitigation option. To calculate this, one needs to convert flood loss data into 'potential OPTIONS: average annual losses'.

FLOOD RISK REDUCTION:

An integrated risk management approach should aim at preventing a flood hazard turning into a disaster. Flood risks being the construct of flood hazards, exposure of economic activities and the vulnerability of the society affected by floods, it is crucial that options to reduce flood risks. Below is a list of options for reducing each constituent of flood risks. This is not an exhaustive list but pointers to the possible means.

These actions are taken depending on the conditions of risk and social, economic and physical setting. Options for reducing flood risks are

1. Reduce hazard
    - Retaining water where it falls
    - Dams and reservoirs

- Diversion channel

2. Reduce exposure
    - Structural measures on the river
    - Land use regulations
    - Flood emergency measures
3. Reduce vulnerability
    - Physical
    - Constitutional
    - Motivational

Flood hazards could be reduced by adopting different aproaches say, by moderating the flood peaks or delaying flood peaks by retarding the surface runoff.Either can be achieved in many ways.For example, the flood peaks could be moderated by retaining water where it falls or by diverting and retaining the surface runoff in natural or artificial depressions or storing it in an on-stream reservoir or a combination of these.Each one of the possible options of reducing flood hazard would have its functional efficiency,economic viability and environmental acceptability.Similarly,flood risks could also be reduced by preventing exposure to flooding up to a certain magnitude through construction of levees.

DROUGHT AND DEVELOPMENT:

Drought is a recurring feature in many parts of Asia.Drought cannot be seen as mere physical phenomenon any more and each drought produces a unique set of impacts,depending not only on its severity,duration,and spatial extent but also on ever-changing social conditions.

The complex interplay of climate factors and non-climate factors results in wide spread and sometimes irreversible impacts on vulnerable livelihood systems.During a drought season,low rainfall in many parts of the region and consequent depressed agricultural production and erosion of productive assests can result in malnutrition,migration and shifts in occupational patterns.

DROUGHT RELIEF, MANAGEMENT AND PREVENTION:

Drought relief is an activity under drought management. However, it is initiated only after drought conditions occur in an area. Various other terminologies like watch; monitoring, mitigation, proofing and prevention are connected to the drought. They form part of activities under drought management.

Drought proofing is a holistic approach of securing livelihoods in a drought prone area through water harvesting and management interventions. The United Nations development programme has supported a drought proofing project for the district of Kutch in Gujarat, India, with assistance from the government of Netherlands. As part of the project, UNDP in association with the govt. of Gujarat, and its implementing partner Abhiyan has set up a Kutch ecological fund (KEF). The project aims to support and facilitate the planning and implementation of initiatives towards long-term recovery and drought proofing of the region.

DROUGHT MONITORING:

One of the important activities under drought management is monitoring. It is primary to providing any relief to the drought affected co-ordination of drought relief is coupled with advance and preventive action to minimize the impact of drought. Drought monitoring is directly related to rainfall and projected availability of water in an area. The associated factors like availability of ground water, Reservoir position and pest control also form part of drought monitoring.

DROUGHT MITIGATION AND MANAGEMENT-INTEGRATING TECHNOLOGY AND PEOPLE:

Droughts are here to stay. As things appear to be currently moving, droughts, will in fact, become an increasingly frequent phenomenon, particularly in the light of the impending projections as a result of climate change. However, the answer to droughts lies not in addressing precipitation issues, but in addressing water management issues. Harvesting, equitably distributing, carefully monitoring and wisely managing our water resources can help us live with droughts, which will be reduced to water stresses, and eventually mere incontinences taken care of through planning, if only we were able to apply technology, traditional wisdom and management systems to our water resources.

Assignment-Cum-Tutorial Questions

A. Questions testing the remembering / understanding level of students

I) Objective Questions

1. Flood is a _____ type of disaster.
2. A_____ is a situation caused due to extended period of rain deficiency.
3. An area is declared by the government as drought affected when the rainfall in the region is less than _____ % of the average annual rainfall.
4. When the average annual rainfall is less than 50 %, then that area is declared as _____ affected area.
5. _____ is a technique where remote sensing and GIS technologies are used in flood management.
6. The chronic flood prone river basin in India are _____ and _____
7. _____ is one of the major reason associated with the floods.
8. The programme implemented by the government of India in drought identified districts of the country is _____

II) Descriptive Questions

1. Define flood.
2. What is meant by a drought?
3. Explain the concept of raising flood damage.
4. Write mathematical expression for risk.
5. What are the elements of flood risk?
6. What are the various stages in assessing flood risk?
7. What is meant by drought monitoring?
8. Write a short note on the issues in drought management.

B. Question testing the ability of students in applying the concepts.

I) Multiple Choice Questions:

1. A flash flood is a flood that:
   a) is caused by heavy rain rather than from the flooding of a river
   b) Both a and d
   c) occurs suddenly and unexpectedly and for a short duration
   d) is caused by the blocking of drains.

2. A flood can vary in:
   a) size
   b) speed of water flow
   c) Duration
   d) All of the above.

3. The size of a flood is measured by:
   a) the rate of flow of water in a waterway or river
   b) the level of water in a waterway or river
   c) a river gauging station

d) all of the above.

4. Which of the following potentially affects the size of a flood?
   a) bridges and other structures in waterways
   b) the size and windiness of a river
   c) vegetation in and around a river
   d) all of the above.

5. In Australia, the most expensive natural disaster is:
   a) drought b)floods
   c) bushfires d)cyclones

6. Which of the following is an environmental consequence of floods?
   a) dispersal of weed species
   b) erosion of soil
   c) release of pollutants into waterways
   d) All of the above

7. Drought is which type of disaster?
   a) Natural b)manmade
   c) Geophysical d)All of the above

8. Percentage of area that prone to drought
   a) 68 b) 69 c) 67 d) 66

II) Descriptive Questions

1. Briefly explain drought relief management and prevention
2. Explain drought and development
3. Write the use of drought in integrating technology and people
4. Explain the flood risk reduction options
5. Explain in detail how to assess flood risk.
6. Describe the process of response and rehabilitation after river erosion.
7. Write the differences between meteorological drought and agricultural drought.
8. Describe flood hazard assessment and flood impact assessment.

UNIT-IV

OBJECTIVES:

- To learn about Landslide and earthquake disaster occurrence and remedial measures

SYLLABUS:

Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide. Studies in rock mass classification and land slide management in a part of Garwal-Himalaya, India. Causes and effects of earthquakes. Second ary effects. Criteria for earthquake resistant design.

Learning Outcomes:

At the end of the lesson, the student will be able to

- explain Land slide hazard zonation mapping
- explain electrical resistivity method
- explain causes and effects of earthquakes
- explain criteria for earthquake resistant design

LANDSLIDE

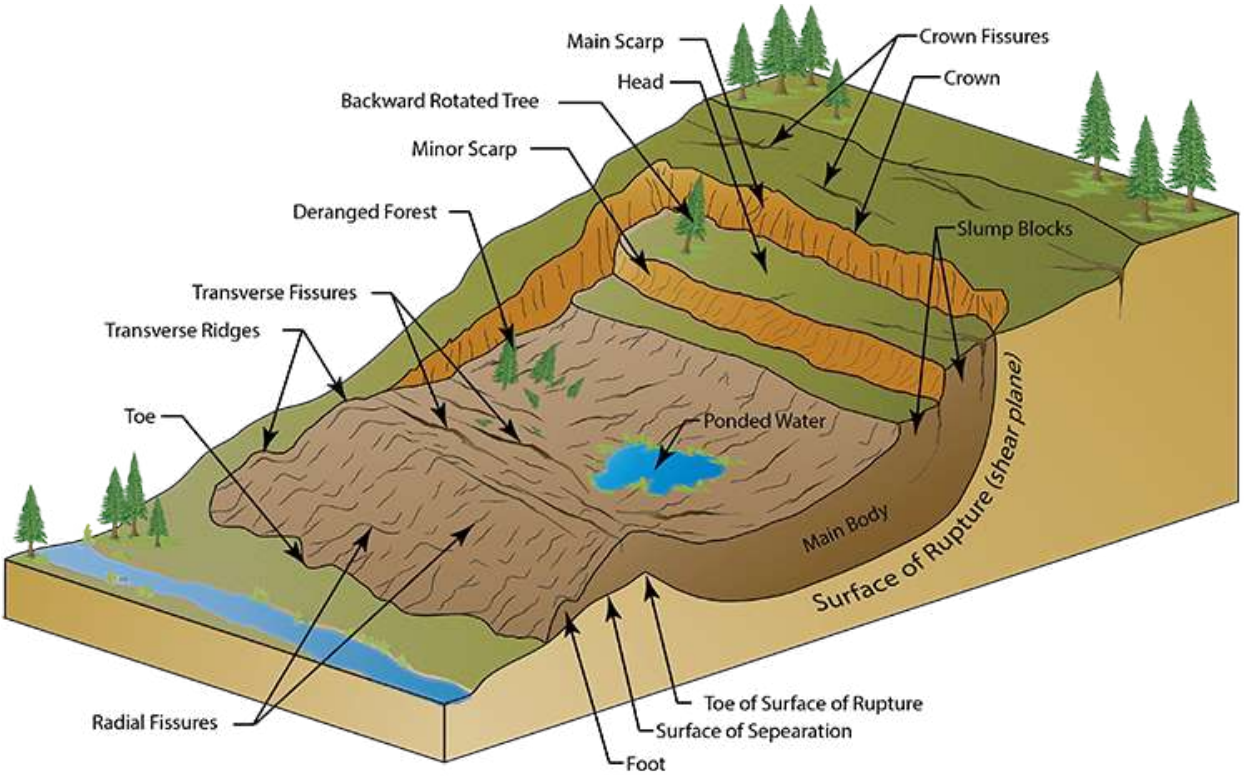
A **landslide**, also known as a **landslip**, is a form of mass wasting that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows.

LANDSLIDE HAZARD ZONATION

Landslide hazard is commonly shown on maps, which display the spatial distribution of hazard classes (Landslide Hazard Zonation). Landslide hazard zonation refers to "the division of the land in homogeneous areas or domains and their ranking according to degrees of actual / potential hazard caused by mass movement"

Landslide failures have caused untold number of causalities and huge economic losses. In many countries, economic losses due to landslides are great and apparently are growing as development expands into unstable hillside areas under the pressure of expanding populations. Inspite of improvements in recognition, prediction, and mitigation measures, worldwide landslide activity is increasing. The factors causing this expected augmented activity are:

- Increased urbanization and development in landslide prone Areas.
- Continued deforestation of landslide prone areas, and
- Increased regional precipitation caused by changing climate patterns.



USES OF LANDSLIDE HAZARD ZONATION

- The LHZ maps have multi uses, some of which are listed below.
- The LHZ maps identify and delineate unstable hazard-prone areas, so that environmental regeneration programmes can be initiated adopting suitable mitigation measures.
- These maps help planners to choose favorable locations for sitting development schemes such as townships, dams, roads and other developments.
- General purpose master plans and land use plans.
- Discouraging new development in hazard prone areas.
- Choice of optimum activity pattern based on risk zones.
- Quick decision making in rescue and relief operations.

Landslide hazard map:

Several kinds of maps are used to depict danger from landslides. These maps may be as simple as a map that uses the locations of old landslides to indicate potential instability, or as complex as a

quantitative map incorporating probabilities based on variables such as rainfall, slope angle, soil type, and levels of earthquake shaking. The term “landslide hazard map” (see specific definition below) is sometimes loosely applied to any of these. The following types of maps are used to describe and depict landslide hazards:

Landslide inventory maps:

Landslide inventory maps show landslide locations and may show the dimensions and geographical extent of each landslide. Because one clue to the location of future land sliding is the distribution of past movement, maps that show the location and size of landslides are helpful in predicting the hazard for an area. Inventory maps do not indicate the landslide possibility in the area between the mapped landslides. For that, hazard, risk, or susceptibility maps are needed. A landslide inventory is a data set that may represent a single event, a regional event, or multiple events. Small-scale maps may show only landslide locations, whereas large-scale maps may distinguish landslide sources from deposits and classify different kinds of landslides and show other pertinent data.

Landslide susceptibility maps:

Landslide susceptibility maps describe the relative likelihood of future land sliding based solely on the intrinsic properties of a locale or site. Some organizations use the term “landslide potential map” for maps of this kind. Prior failure (from a landslide inventory), rock or soil strength, and steepness of slope are three of the more important site factors that determine susceptibility. The California Geological Survey relies on these three factors for producing its landslide susceptibility maps. However, other factors, such as fracture spacing for rock slopes, and the presence of faults and other geologic structures, are commonly used by others in preparing susceptibility maps.

Landslide hazard maps:

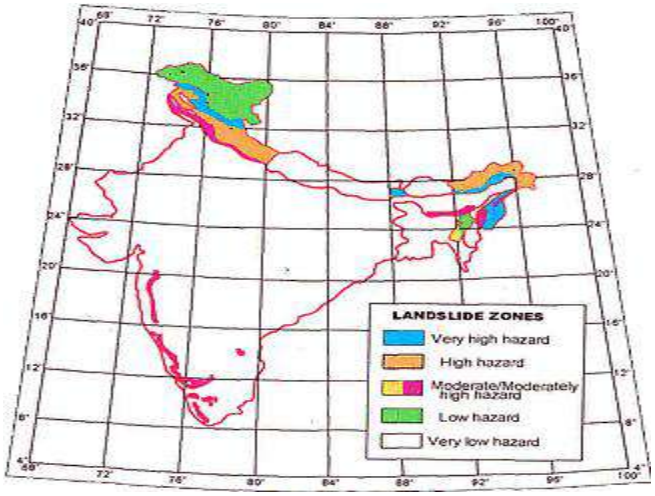
Landslide hazard maps indicate the possibility of landslides occurring throughout a given area. An ideal landslide hazard map shows not only the chances that a landslide may form at a particular place, but also the chance that it may travel down slope a given distance. The California Geological Survey for example, applies the term “landslide potential map” to a specific type of hazard map that describes the likelihood of land sliding (susceptibility) jointly

with the occurrence of a triggering event (opportunity). Potential commonly is based on the three factors determining susceptibility plus an estimate or measure of the probability (likelihood of occurrence) of a triggering event such as earthquake or excessive rainfall. Examples of landslide hazard maps

Landslide risk maps:

Landslide risk maps show landslide potential along with the expected losses to life and property, should a landslide occur. Risk maps combine the probability information from a landslide hazard map with an analysis of all possible consequences (property damage, casualties, and loss of service).

A general landslide hazard map of India shown here marks the areas of different hazard zones in various states of India; one may note that Himalayas of Northwest and Northeast India and the Western Ghats are two regions of high vulnerability and are landslide prone.



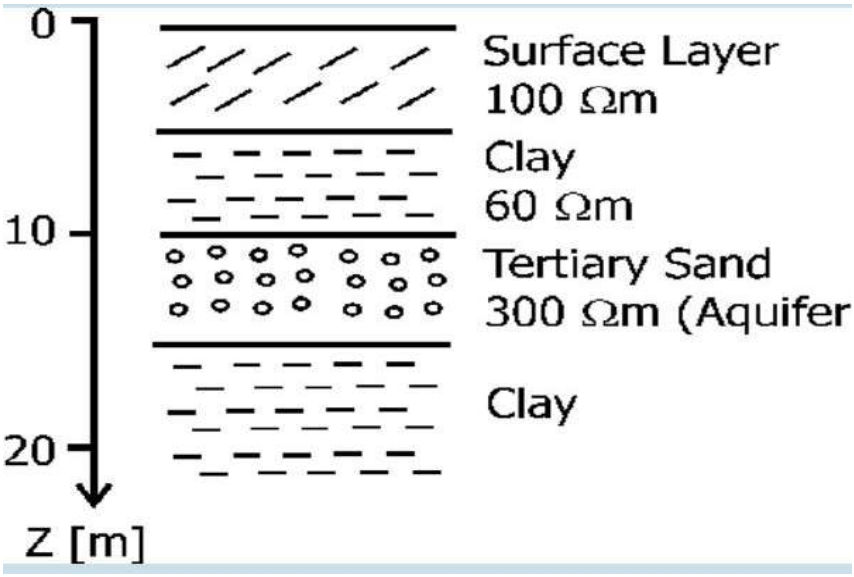
NDMA guidelines are being followed for Landslide Hazard Zonation (LHZ) maps at 1: 50,000 scale and progressively larger scales for specific areas.

Electrical resistivity method

- The resistivity method is used in the study of horizontal and vertical discontinuities in the electrical properties of the ground.
- It utilizes direct currents or low frequency alternating currents to investigate the electrical properties (resistivity) of the subsurface.
- A resistivity contrast between the target and the background geology must exist.

Possible applications of resistivity surveying

- Groundwater exploration
- Mineral exploration, detection of cavities
- Waste site exploration



ELECTRICAL RESISTIVITY TEST –GEOPHYSICAL METHOD

This method depends on differences in the electrical resistance of different soil (and rock) types. The flow of current through a soil is mainly due to electrolytic action and therefore depends on the concentration of dissolved salts in the pores. The mineral particles of soil are poor conductors of current. The resistivity of soil, therefore, decreases as both water content and concentration of salts increase.

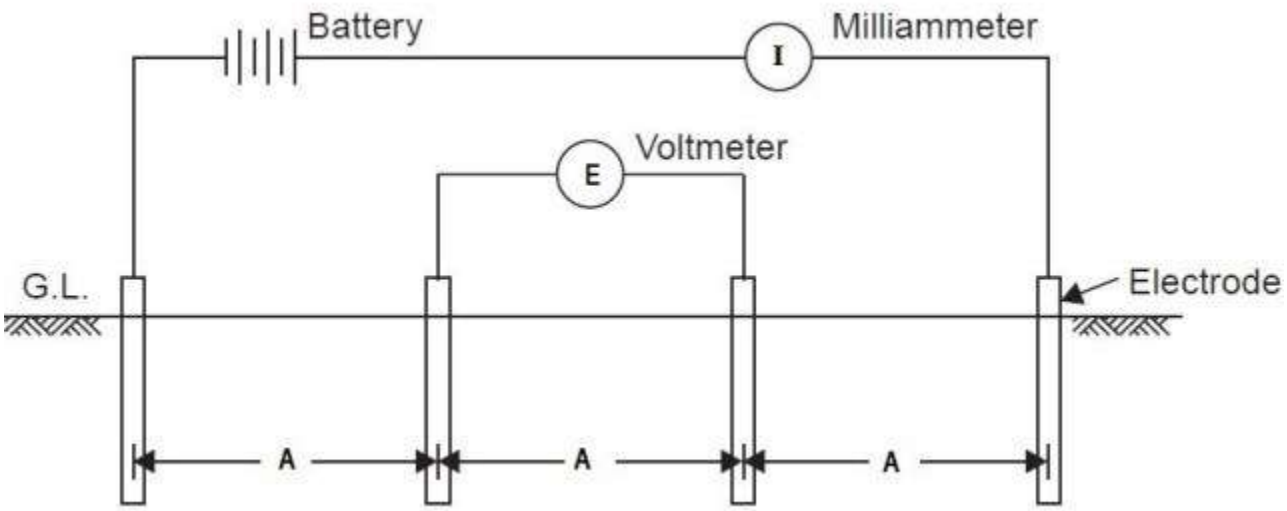
Dense clean sand above the water table, for example, would exhibit a high resistivity due to its low degree of saturation and virtual absence of dissolved salts. Saturated clay of high void ratio, on the other hand, would exhibit a low resistivity due to the relative abundance of pore water and

the free ions in that water.

There are several methods by which the field resistivity measurements are made. The most popular of the methods is the Wenner Method.

Wenner Method:

The Wenner arrangement consists of four equally spaced (**A**) electrodes driven approximately 20 cm into the ground as shown in the following figure.



Wenner's Arrangement for Electrical Resistivity Test of Soil

In this method a dc current of known magnitude (**I**) is passed between the two outer (current) electrodes, thereby producing an electric field within the soil, whose pattern can be determined by the resistivities of the soils present within the field and the boundary conditions. By means of the inner electrodes the potential drop '**E**' for the surface current flow lines is measured. The apparent resistivity '**R**', is calculated using the following equation

$$R = \frac{2\pi AE}{I}$$

Where,

A in centimeters,

E in volts,

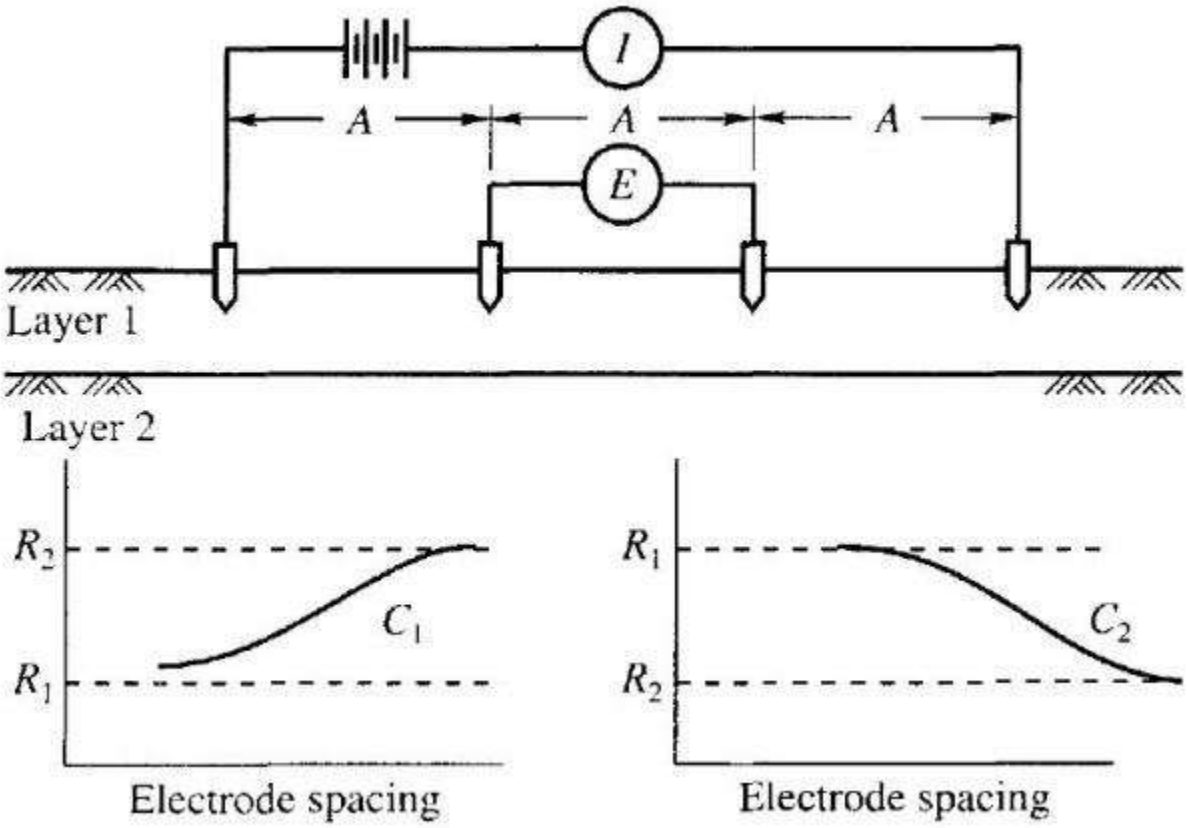
I in amperes, and

R in ohm-cm

The apparent resistivity represents a weighted average of true resistivity to a depth **A** in a large volume of soil, the soil close to the surface being more heavily weighted than the soil at greater depths. The presence of a stratum of low resistivity forces the current to flow closer to the surface resulting in a higher voltage drop and hence a higher value of apparent resistivity. The opposite is true if a stratum of low resistivity lies below a stratum of high resistivity.

The method known as electrical sounding is used when the variation of resistivity with depth is required. This enables rough estimates to be made of the types and depths of strata. A series of readings are taken, the (equal) spacing of the electrodes being increased for each successive reading. However, the center of the four electrodes remains at a fixed point. As the spacing is increased, the apparent resistivity is influenced by a greater depth of soil. If the resistivity increases with the increasing electrode spacing, it can be concluded that an underlying stratum of higher resistivity is beginning to influence the readings. If increased separation produces decreasing resistivity, on the other hand, a lower resistivity is beginning to influence the readings.

Apparent resistivity is plotted against spacing, preferably, on log paper. Characteristic curves for a two layer structure are shown in the following figure.



Electrical Resistivity Test – Schematic Representation

For curve C_1 the resistivity of layer 1 is lower than that of layer 2; for curve C_2, layer 1 has a higher resistivity than that of layer 2. The curves become asymptotic to lines representing the true resistance R1 and R2 of the respective layers. Approximate layer thickness can be obtained by comparing the observed curves of resistivity versus electrode spacing with a set of standard curves. The procedure known as electrical profiling is used in the investigation of lateral variation of soil types. A series of readings is taken, the four electrodes being moved laterally as a unit for each successive reading; the electrode spacing remains constant for each reading of the series. Apparent resistivity is plotted against the center position of the four electrodes, to natural scale; such a plot can be used to locate the position of a soil of high or low resistivity. Contours of resistivity can be plotted over a given area. The electrical method of exploration has been found to be not as reliable as the seismic method as the apparent resistivity of a particular soil or rock can vary over a wide range of values. Representative values of resistivity are given in the following table.

Representative values of resistivity. The values are expressed in units of 10^3 ohm-cm(after

Peck et al, 1974)

Material	Resistivity (ohm-cm)
Clay and saturated silt	0 – 10
Sandy clay and wet silty sand	10 – 25
Clayey sand and saturated sand	25 – 50
Sand	50 – 150
Gravel	150 – 500
Weathered rock	100 – 200
Sound rock	150 – 4000

Geo Environmental Problems associated with Landslides:

Himalayan terrain is highly prone to landslide hazards as compared to other physiographic divisions of India. Unstable geological conditions, heavy rainfall, cloudbursts, anthropogenic activities (excessive construction, deforestation etc.) etc. have been mainly responsible for several landslides resulting into loss of life and property or both. Due to these natural hazards, the Himalayan region is facing major problems of environmental degradation. Because of the geographic location of Himalaya in the path of moisture laden South-West Monsoon winds, this region receives heavy annual precipitation as orographic rainfall in its windward side. It is the source region for all the perennial North Indian rivers. Because of its regional elevation, all the major and minor rivers originating from this region, are in their youth stage. As a result there is tremendous down cutting of the river valleys for which we get many gorges and V-shaped valleys in this region. This leads to toe erosion of the hill slopes especially along the river bends. Hence, any improperly planned construction and associated excavations, in the name of development, which lacks proper geological and geotechnical investigations, is a cause of concern for stability for that hill slope in the Himalayan region. Now, for a long time back in the Geological Time Scale, any natural body having some significant relief is always being affected by the agents of weathering and erosion, leading to the reduction of its height and modification to a peneplain. So, the hill slopes are also not exceptional to this rule. In fact, this is a very important part of the rock cycle where we get formation of the sedimentary rocks. Apart from the relief there are other controlling factors like lithology, orientation of the discontinuity planes with respect to the slope, ground water condition in the slope, etc. which can be considered as controlling parameters in

this process of modification of the hill slopes. Such slopes become highly unstable if it is located in a seismically active terrain or zones of high annual precipitation and they may act as a triggering factor for a landslide. In this circumstances if there is human interaction by means of unplanned constructional activities like excavations, then it causes instability of slopes. So, the ultimate and cumulative effect of all of these factors is the sudden movement of slope forming materials, down the slope, mostly along a plane of discontinuity. This is called a landslide or in a broad sense, may be called as mass wasting. Since the formation of the hill state of Uttarakhand state, there is a rapid surge of road construction, all over the state. This is being done because the economy of this newly formed state by many ways is tourism based. But the fast rate of road construction does not often incorporate the essential geological parameters which are a necessity for stability of existing slopes. As a consequence, unplanned excavations may cause the cut slopes more vulnerable to failure. Hence a fast appraisal of the existing roads, particularly in the vulnerable sections will help to identify the landslide hazard prone slopes.

Causes and Effects of Earthquakes

Earthquake refers to the sudden violent movement of the earth's crust. It creates seismic waves. It often causes great destruction. Its causes and effects are mentioned below.

Causes of Earthquakes

The important causes of the earthquake are:

Natural Causes of Earthquake:

1. **Tectonic Movement:** This particularly happens when the continental plate collides against the oceanic plate. The oceanic plate is overridden by the continental plate. By a process called subduction jerky movements are caused along the inclined surface. Tectonic earthquakes have occurred in Assam in 1950.
2. **Volcanic Activity:** Earthquakes may also be caused by the movement of lava beneath the surface of the earth during volcanic activity. The earthquakes due to Krakatoa volcanic eruption in 1883 is a good example of volcanic eruption.

3. **Dislocation of the Earth's crust:** Earthquakes may be caused by the dislocation of the crust beneath the surface of the Earth.
4. **Adjustment in inner Rock Beds:** Earthquakes are also caused where is an adjustment between Sima [i.e., beneath the ocean is formed by Silica and Magnesium = Si + ma = Sima] and Sial (i.e., Continent is formed by Silica and Aluminium = Si + al = Sial) in the interior of the Earth's Crust. This Earthquake may be called as a Plutonic Earthquake.
5. **Pressure of gases in the interior:** The expansion and contraction of gases in the interior of the Earth sometimes cause a sudden shake on the Earth's surface.

   Other Causes:

   1. Landslides and avalanches,
   2. Denudation of the Landmasses and depositions of materials,
   3. Faulting and folding in the rock beds are responsible for causing minor earthquakes.

Man-made Earthquakes:

1. The impounding of large quantities of water behind dams disturbs the crustal balance. This causes earthquakes such as the Koyna earthquake in Maharashtra.
2. The shock waves through rocks set up by the underground testing of Atom bombs or Hydrogen bombs may be severe to cause earthquake.

Effects of Earthquake:

Effects are often classified as primary and secondary impacts. Primary effects occur as a direct result of the ground shaking, eg buildings collapsing. Secondary effects occur as a result of the primary effects, eg tsunamis or fires due to ruptured gas mains.

Primary Effects:

1. Earthquake causes dismantling of buildings, bridge and other structures at or near

epicenter. Many men and animals are killed or buried under collapsed houses.

2. Rails are folded, underground wires broken. Fire breaks out inevitably in large towns.
3. Earthquakes originate sea waves called Tsunamis.
4. Earthquakes result in the formation of cracks and fissures on the ground formation.
5. The earthquakes cause landslides and disturb the isostatic equilibrium.
6. Landslide due to earthquake may block valleys to form lakes.

Secondary effects of earthquakes:

Strong earthquakes in particular often trigger secondary effects which also have a high loss potential and are usually the prime factor for determining whether an earthquake is categorised as a catastrophe. These are the main secondary effects:

- Amplification
- Seismic sea waves (tsunamis)
- Liquefaction
- Landslides
- Surface rupture
- Fire following earthquake

Criteria for Earthquake Resistant Design:

Experience in past earthquakes has demonstrated that many common buildings and typical methods of construction lack basic resistance to earthquake forces in most cases this resistance can be achieved by following simple inexpensive principles of good building construction practices. Adherence to these simple rules will not prevent all damage in moderate or large earthquakes, but life threatening collapses should be prevented, and damage limited to repairable proportions. These principles fall into several broad categories:-

(i) Planning and layout of the building involving considerations of the location of rooms and walls, openings such as doors and windows, the number of storeys etc. At this stage, site and foundation aspects should also be considered.

(ii) Lay out and general design of the structural framing system with special attention to furnishing lateral resistance, and

(iii) Consideration of highly loaded and critical sections with provision of reinforcement as required.

From my general study, certain general principles have emerged:-

(i) Structures should not be brittle or collapse suddenly rather they should not be tough, able to deflect or deform a considerable amount

(ii) Resisting elements such as bracing on shear walls, must be provided evenly throughout the buildings in both directions side to side, as well as top to bottom.

(iii) All elements such as walls and the roof should be tied together so as to act as an integrated unit during earthquake shaking transferring forces across connections and preventing separation.

(iv) The building must be connected to a good foundation and the earth wet soil should be avoided and the foundation must be well tied together as well tied to the wall where the soft soils strengthening must be provided.

(v) Care must be taken that all materials used are of good quality and are protected from sun, rain, insects and other weakening actions so that their strength lasts.

(vi) Unreinforced earth and masonry have no reliable strength in tension, and are brittle in compression. Generally they must be suitably reinforced by steel or wood.

DESIGN PHILOSOPHY

1. Under minor but frequent shaking, the main members of the buildings that carry vertical and horizontal forces should not be damaged; however buildings parts that do not carry load may sustain repairable damage.
2. Under moderate but occasional shaking, the main members may sustain repairable damage, while the other parts that do not carry load may sustain repairable damage.
3. Under strong but rare shaking, the main members may sustain severe damage, but the building should not collapse.

Earthquake resistant design is therefore concerned about ensuring that the damages in buildings during earthquakes are of acceptable variety, and also that they occur at the right places and in right amounts. This approach of earthquake resistant design is much like the use of electrical fuses in houses: to protect the entire electrical wiring and appliances in the house, you sacrifice some small parts of electrical circuit, called fuses; these fuses are easily replaced after the electrical over-current. Likewise to save the building from collapsing you need to allow some pre-determined parts to undergo the acceptable type and level of damage.

Categories of buildings

For categorizing the buildings with the purpose of achieving seismic resistance at economical cost three parameters turns out to be significant:

(i) Seismic intensity zone where the building is located.

(ii) How important the building is and

(iii) How stiff is the foundation soil

A combination of these parameters will determine the extent of appropriate seismic strengthening of the building.

Seismic zones

In most countries, the macro level seismic zones are defined on the basis of seismic intensity

scales in this guide, we shall refer to seismic zones:-

ZONE A:- Risk of widespread collapse and destruction

ZONE B:-Risk of collapse and heavy damage

ZONE C:-Risk of minor damage

Importance of building

The importance of the building should be a factor in grading it for strengthening purposes and the following buildings are suggested as specially important.

Important buildings-Hospitals, clinics, communication buildings, fire and police stations, water supply facilities, cinemas, meeting halls, schools, cultural treasures such as museums, monuments and temples etc.

Ordinary buildings:-Housing, hostels, offices, warehouses, factories etc.

Bearing capacity of foundation soil

Three soil types are considered here:-

Firm: Those soils which have an allowable bearing capacity of more than 10 t/m2

Soft: those soils which have an allowable bearing capacity less than or equal to 10 t/m2

Weak: Those soils which are liable to large differential settlement or liquefaction during earthquake

Buildings cannot be constructed on firm and soft soils but it will be dangerous to build them on weak soils. Hence appropriate soil investigations should be carried out to establish the allowable bearing capacity and nature of soil.

Choice of site

The choice of site for building from the seismic point of view is mainly concerned with the

stability of the ground. The following are important:

1) Stability of slope: hill side slopes liable to slide during an earthquake should be avoided and only stable slopes should be chosen to locate the building. Also it will be preferable to have several blocks on terraces than have one large block with footings at very different elevations. A site subject to the danger of rock falls has to be avoided.

2) Very loose sand or sensitive clays:-These two types of soils are liable to be destroyed by the earthquake so much as to lose their original structure and thereby undergo compaction. This would result in large unequal settlement and damage the building. If the loose cohesions soils are saturated with water they are apt to lose their shear resistance altogether during shaking and become liquefied.

Requirements of structural safety

(i) A pre standing wall must be difficult to achieve in un-reinforced masonry in zone A. Therefore all partitions inside the buildings must be held on the sides as well as top. Parapets must be reinforced and held to the main structural slabs of frames.

(ii) Horizontal reinforcement in walls is required for transferring their own out of plane inertia load horizontally to shear walls.

(iii) The walls must be effectively tied together to avoid separation at vertical joints due to ground shaking.

(iv) Shear walls must be present along both axes of building.

(v) A shear wall must be capable of resisting all horizontal forces due to its own mass and those transmitted to it.

(vi) Roof or floor elements must be tied together and be capable of exhibiting diaphragm action.

(vii) Trusses must be anchored to the supporting walls and have an arrangement for transferring their inertia force to end walls.

CONCEPTS OF DUCTILITY,DEFORMABILITY AND DAMAGEABILITY

1. DUCTILITY-Formally, ductility refers to the ratio of the displacement just prior to ultimate displacement or collapse to the displacement at first damage or yield. Some materials are inherently ductile such as steel, wrought iron and wood. Other materials are not ductile such as cast iron.

2. DEFORMABILITY-Ability of a structure to displace or deform substantial amounts without collapsing. Besides inherently relying on ductility of materials and components, deformability requires that structures be well proportioned, regular and well tied together so that excessive stress concentration are avoided and avoided and forces are capable of being transmitted from one component to another even through large deformations.

3. DAMAGEABILITY-Damageability is also a desirable quality for construction and refers to the ability of a structure to undergo substantial damages, without partial or total collapses.

A key to good damageability is redundancy or provision of several supports for key structural members, such as ridge beams and avoidance of central columns or walls supporting excessively large portions of a building.

CONCEPT OF ISOLATION

For reduction of coefficient of friction between the structures and its foundation, one suggested technique is to place two layers of good quality plastic between the structures and its foundation so that the plastic layers may slide over each other.

FOUNDATIONS

For the purpose of making a building truly earthquake resistant, it will be necessary to choose an appropriate foundation type for it .since loads from typical low height buildings will be light, providing the required bearing area will not usually be a problem. The depth of footing in the soil should go below the zone of deep freezing in cold countries and below the level of shrinkage cracks in clayey soils.

FIRM SOIL

In firm soil conditions, any type of footing can be used. It should be of course have a firm base of lime or cement concrete with requisite width over which the construction of the footing may start. It will be desirable to connect the individual reinforced concrete column footings in zone A by means of RC beams just below plinth level intersecting at right angles.

SOFT SOIL

In soft soil, it will be desirable to use a plinth band in all walls and where necessary to connect the individual column footings by means of plinth beams suggested above. It may be mentioned that continuous reinforced concrete footings are considered to be most effective from earthquake considerations as well as to avoid differential settlements under normal vertical loads. These should ordinarily be provided continuously under all the walls. Continuous footings should be reinforced both in the top and bottom faces, width of the footing should be wide enough to make the contact pressures uniform and the depth of footing should be below lowest level of weathering.

DM Unit-5

Cyclone and Occurrence of cyclone:

A cyclone is a region of low atmospheric pressure, which occurs in the hot oceans of temperate and tropical latitudes. It is a swirling atmospheric disturbance, accompanied by powerful winds (exceeding the 300 km/h sometimes) blowing in a clockwise direction in the Northern hemispheres and anti clock wise direction in the Southern hemisphere, by pouring rain, and enormous waves in the ocean. Cyclones occur due to a combination of warm sea temperature, high relative humidity and atmospheric instability. In a cyclone, clouds gather around a centre that is called the "eye of the cyclone". A zone of calm, accompanied by good weather characterizes the eye. It is in edge of the eye called the "wall of the eye" (in a radius of 20 to 30 kilometers) that the worst conditions prevail, with devastating winds. So, as the eye of the cyclone crosses an area, the wind drops. As it passes, the wind speed rises again, and hence the calm should not be confused as the 'end' of the cyclone. The diameter of the cyclone is often several hundreds of kilometers. That of the eye varies between 20 and 50 km and the cloudy mass of the cyclone raises to occupy all of the troposphere. Cyclones form when there is a combination of warm tropical water (above 26.5^0 C), high relative humidity and increased precipitation. This ultimately drives atmospheric energy to form a cyclone and once formed they can persist for many days and follow unpredictable paths. When cyclones travel across land or colder oceans, they usually dissipate as driving forces decrease.

Categories of Cyclones

Cyclones are categorized according to wind speeds and the damage they cause.

Category 1 Cyclone: Wind speeds between 90 and 125 kilometres per hour, some noticeable damage to houses and trees.

Category 2: Wind speeds between 125 and 164 kilometres per hour, damage to houses and significant damage to crops and trees.

Category 3: Wind speeds between 165-224 kilometres per hour, structural damage to houses, extensive damage to crops and uprooted trees, upturned vehicles and destruction of buildings.

Category 4: Wind speeds between 225 and 279 kilometres per hour, power failure and much damage to cities and villages.

Category 5: Wind speeds over 280 kilometres per hour, widespread damage.

Cyclone Warning System in India

The Indian Meteorological Department is responsible for forecasting the occurrence of cyclones, for estimating and categorizing them, and for issuing warnings when necessary. Cyclones in the Bay of Bengal and in the Arabian Sea are predicted by the Area Cyclone Warning Centres (ACWC) and the Cyclone Warning Centres (CWC) departments of the IMD respectively. The National Cyclone Warning Centre (NCWC) in New Delhi acts as a coordinator between the two. In 2014, the IMD launched an SMS based cyclone warning system that shall enable the masses to stay alert and prepared in the event of an approaching cyclone. From time to time the Indian Army and the Indian Air Force have also been roped in to rescue Indians from the devastation caused by tropical cyclones. Apart from this the National Disaster Response Force (NDRF) is responsible for relief operations.

What happens during a cyclone?

The principal dangers from a cyclone are:

(i) Gales and strong winds; (that may uproot trees; destroy telephone lines and electricity poles which may disable power and communication)

(ii) Torrential rain that can cause flooding

(iii) High tidal waves (also known as 'storm surges'). Most casualties are caused by coastal inundation by tidal waves and storm surges.

The rise in water level caused by a storm surge can cause severe flooding in coastal areas, particularly when this surge coincides with the normal high-tide. Preparing for cyclones

Knowing about the areas that are most likely to be hit by cyclones is the first step towards preparedness. Cyclones usually occur between 5-20 degrees latitude, North and South of the equator.

<u>Destruction caused by Cyclones</u>

There are three elements associated with a cyclone, which cause destruction. They are explained in the following paragraphs:

1. Cyclones are associated with high-pressure gradients and consequent strong winds. These, in turn, generate storm surges. A storm surge is an abnormal rise of sea level near the coast caused by a severe tropical cyclone; as a result, sea water inundates low lying areas of coastal regions drowning human beings and live- stock, eroding beaches and embankments, destroying vegetation and reducing soil fertility.
2. Very strong winds may damage installations, dwellings, communication systems, trees., etc. resulting in loss of life and property.
3. Heavy and prolonged rains due to cyclones may cause river floods and submergence of low lying areas by rain causing loss of life and property. Floods and coastal inundation due to storm surges pollute drinking water sources causing outbreak of epidemics.

It may be mentioned that all the three factors mentioned above occur simultaneously and, therefore, relief operations for distress mitigation become difficult. So it is imperative that advance action is taken for relief measures before the commencement of adverse weather conditions due to cyclones.

The most destructive element associated with an intense cyclone is storm surge. Past history indicates that loss of life is significant when surge magnitude is 3 metres or more and catastrophic when 5 meters and above.

Cyclone resistant house for coastal areas:

	Choose the location carefully to avoid the full force of the wind or flood
	Use building layout with a simple regular shape, to avoid concentration of pressure.
	Build the roof at an angle of 30° to 45° to prevent it being lifted off by the wind.
	Avoid wide roof overhangs; separate the veranda structure from the house.
	Make sure the foundations, walls, and roof structure are all firmly fixed together.

	Reinforce the bracing in the structure; strengthen walls and joints/ junctions to increase stiffness.
	Make sure the roof covering is firmly attached to the roof structure to prevent it from lifting.
	If doors & shutters cannot be shut, make sure there are opposing openings to reduce pressure build up.
	Use doors and shutters that can be closed.
	Plant trees around the house as wind breaks and reduce flow of water, but not too close.

Fire safety is the set of practices intended to reduce the destruction caused by fire. Fire safety measures include those that are intended to prevent ignition of an uncontrolled fire, and those that are used to limit the development and effects of a fire after it starts.

Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing, and those that are taught to occupants of the building.

Threats to fire safety are commonly referred to as fire hazards. A fire hazard may include a situation that increases the likelihood of a fire or may impede escape in the event a fire occurs.

Fire safety is often a component of building safety. Those who inspect buildings for violations of the Fire Code and go into schools to educate children on Fire Safety topics are fire department members known as Fire Prevention Officers. The Chief Fire Prevention Officer or Chief of Fire Prevention will normally train newcomers to the Fire Prevention Division and may also conduct inspections or make presentations.

Classes of Fire - A, B, C, D, and K

Fires are classified by the types of fuel they burn.

Class A

Class A Fires consist of ordinary combustibles such as wood, paper, trash or anything else that leaves an ash. Water works best to extinguish a Class A fire.

Class B

Class B Fires are fueled by flammable or combustible liquids, which include oil, gasoline, and other similar materials. Smothering effects which deplete the oxygen supply work best to extinguish Class B fires.

Class C

Class C Fires. Energized Electrical Fires are known as Class C fires. Always de-energize the circuit then use a non-conductive extinguishing agent. Such as Carbon dioxide.

Class D

Class D Fires are combustible metal fires. Magnesium and Titanium are the most common types of metal fires. Once a metal ignites do not use water in an attempt to extinguish it. Only use a Dry Powder extinguishing agent. Dry powder agents work by smothering and heat absorption.

Class K

Class K Fires are fires that involve cooking oils, grease or animal fat and can be extinguished using Purple K, the typical agent found in kitchen or galley extinguishers.

Elements of a fire safety policy

- Building a facility in accordance with the version of the local building code

- Maintaining a facility and conducting oneself in accordance with the provisions of the fire code. This is based on the occupants and operators of the building being aware of the applicable regulations and advice.

Examples of these include:

- Not exceeding the maximum occupancy within any part of the building.
- Maintaining proper fire exits and proper exit signage (e.g., exit signs pointing to them that can function in a power failure)
- Compliance with electrical codes to prevent overheating and ignition from electrical faults or problems such as poor wire insulation or overloading wiring, conductors, or other fixtures with more electric current than they are rated for.
- Placing and maintaining the correct type of fire extinguishers in easily accessible places.
- Properly storing and using, hazardous materials that may be needed inside the building for storage or operational requirements (such as solvents in spray booths).
- Prohibiting flammable materials in certain areas of the facility.
- Periodically inspecting buildings for violations, issuing Orders To Comply and, potentially, prosecuting or closing buildings that are not in compliance, until the deficiencies are corrected or condemning it in extreme cases.
- Maintaining fire alarm systems for detection and warning of fire.
- Obtaining and maintaining a complete inventory of fire stops.
- Ensuring that spray fireproofing remains undamaged.
- Maintaining a high level of training and awareness of occupants and users of the building to avoid obvious mistakes, such as the propping open of fire doors.
- Conducting fire drills at regular intervals throughout the year.

Fire Fighting Methods:

COMBUSTIBLE INVOLVED	TYPE FIRE	USEFUL EXTINGUISHING AGENTS
Woodwork, bedding, clothing, combustible	A	1.Fixed water sprinkling stores 2. High-velocity fog 3.Solid water stream 4.Foam/AFFF 5. Dry Chemical 6. CO_2 Extinguisher
Explosive Propellants	A	1.Magazine sprinkling Propellants 2. Solid water stream or high-velocity fog 3. Foam/AFFF
Paint, spiritsB1. Flammable liquid stores	B	1. CO2(Fixed System) 2. Foam/AFFF 3. Installed sprinklers 4. High-velocity fog

		5. P-K-P Dry Chemical 6. CO_2 Portable
Gasoline	B	1. Foam/AFFF, handline or sprinkler systems 2. CO2(Fixed System) 3. Water sprinkling system 4. P-K-P Dry Chemical
Fuel oil, JP-5	B	1. Foam/AFFF, handline or sprinkler systems 2. P-K-P Dry Chemical 3. Water sprinkling system 4. High-velocity fog 5. CO_2 (Fixed System)
Electrical and radio	C	1. (De-energize affected circuits) 2. Portable CO2or CO2hose reel system 3. High-velocity fog 4. Fog—Foam or Dry Chemical (if CO2not available)
Magnesium Alloys	D	1. Jettison into the sea 2. High-velocity fog—cool 3.Dry Sand—Talc—Smother
Grenades, Napalm	D	1. Dry sodium Chloride 2. Stow in kerosene or similar Hydrocarbon

Fire Detectors:

Smoke and fire detection equipment is an integral part of any building's safety. When working properly, they alert the occupants in a building of a fire before it spreads, giving them enough time to evacuate. This type of equipment comes in many forms: heat detectors, smoke detectors, flame detectors, and CO gas detectors.

Here is an overview of the different types of fire detection equipment.

Unlike other types of alarm systems, heat detectors are not early warning devices. These devices are typically found in spots with fixed temperature, including heater closets, small rooms, and kitchen facilities. They should not be installed in areas with fluctuating ambient temperature. This is because the alarm on heat detectors is set to go off if there is a rise in the temperature. Like their name suggests, these detectors are used to detect flames. When working properly, they detect fire nearly at the point

of ignition. They are very useful for buildings involving with hazardous processes, as well as gas and oil refineries and manufacturing industries.

There are three subcategories of flame detectors: optical, UV, and IR.

- Optical detectors: The most commonly used, these feature optical sensors for detecting flames.
- UV detectors: These work very quickly. They can detect open flames, explosions, and fires within four milliseconds, due to the UV radiation emitted at the instant of ignition. However, to prevent accidental triggers, some UV detectors are designed to integrate a three second time delay.
- IR detectors: Infrared detectors monitor the head radiation that is generated by open flames and fire. They have a response time of three to five seconds. Accidental triggers can be caused by nearby hot surfaces and background thermal radiation. False alarms can be decreased with the use of special programming algorithms, which are designed to recognize the frequency of flame flickering.

- Smoke alarms are designed to detect fires quickly. Like flame detectors, this fire detection equipment is divided into three subcategories.

- Photoelectric alarms: These operate with the use of a light source, photoelectric sensor, and beam collimating system. When smoke begins to enter the optical chamber, it crosses the light beam path. This results in light being scattered by the particles in the smoke. The scattered light is then directed to the sensor, after which the alarm is activated and sounded.
- Ionization alarms: A small amount of radioactive material, which passes through the ionization chamber, is contained inside of these alarms. There are two electrodes inside the chamber, with empty space in between. The radiation permits a small current between the two electrodes. If smoke enters the chamber, it absorbs the alpha particles, which results in an interrupted current and ionization reduction. When this occurs, the alarm is set off.
- Combination alarms: These have the features of both ionization and photoelectric alarm technologies. The photoelectric function responds to low energy smoldering fires, and the ionization function responds to rapid, high-energy fires.

  If you're unsure which type of fire detection equipment to get, have a professional come in to assess your building to determine your requirements. Regardless of which alarm/detection device selected, you should have them professionally installed, and follow all instructions for testing and maintenance.

When to use a fire extinguisher?

Use a Fire Extinguisher When:

- The fire is contained and not spreading
- The extinguisher is readily available
- You know how to use it properly
- Personal safety is not compromised
- There is a clear path for escape

Types of Extinguishers

Dry Chemical

Carbon Dioxide Pressurized Water/Foam

Dry Powder

Wet Chemical

Clean Agent

Fire Extinguisher Labeling

- Labeling on the fire extinguisher identifies which class of fire it is appropriate for; Class A, B, C,D or K and instructions on how to use it.

Class of fire extinguisher is appropriate for Instructions on use

Types of Extinguishers:

Dry Chemical

- Dry Chemical is the most widely used type of fire extinguisher and is also recognized as a multi-purpose ABC fire extinguisher.
- The agent works by interrupting the chemical chain reaction. Also, on a class A fire it creates a barrier between the fuel and the oxygen.

Carbon Dioxide

- Works by separating oxygen and heat.
- Usually ineffective against class A fires.

Water/Foam

- Works by cooling the fire and coating the fuel. Foam extinguishers create a foam barrier preventing the fuel from coming in contact with oxygen.
- Can cause shock hazard on class C fires
- Can cause liquids in class B fires to spread
- Effective on class A fires

Dry Powder

- Works by separating fuel from oxygen and/or removing heat
- Effectiveness is based on the type of class D fire it is designed to extinguish.
- Ineffective on class A,B,C fires (metal fires) only.

Wet Chemical

- Works by forming a soapy foam blanket over the burning material and cooling it below its ignition temperature.
- Designed for restaurant type kitchens.

Clean Agent

- Works by interrupting the chemical chain reaction.

Unit - 6

REHABILITATION

Rehabilitation Programs:

The Government constructed temporary safe shelters in sixteen different parts of the valley. A Cabinet level decision was taken on 30 April 2015 on the various relief measures; some of them were Changed/modified from time to time to make them more realistic:

a. Cremation Cost and Assistance to the Family of Victims:

Family that has lost its member in the earthquake will get NPR 40,000.00 per dead person as cremation cost, which was increased from previously stated NPR 15,000.00 per person. Additionally, the Government will provide a fixed sum of NPR 100,000.00 to each family that has lost its one or more members (i.e. losing more than one member will not multiply this amount).

b. Temporary Shelters/Rehabilitation of those Rendered Homeless:

The Government is committed to ensuring that all the affected population in the crisis hit districts got tents/tarpaulin and other basic items and making necessary arrangements for resettling them safely. Those who wish to repair their partially damaged houses will get a sum of NPR 25,000.00 per family as maintenance cost. And those who wish to rebuild their houses on their own will get a relief assistance of NPR 200,000.00 plus a concessional loan up to NPR 25,00,000.00 in the valley and NPR 15,00,000.00 outside the valley at just two per cent interest rate under "Earthquake Victim Special Loan" scheme. The Government later decided to provide tin sheets or NPR 15,000.00 to each affected family for managing a temporary accommodation in view of the coming monsoon. This amount together with all other relief amounts previously provided will be deducted from the relief of NPR 200,000.00 to be provided to the victims later.

c. Rehabilitation and Reconstruction Plan backed by the NRRF:

An appropriate plan of land pooling for rehabilitation in the affected areas with adequate facilities will be implemented. Such a plan will ensure the building of earthquake resistant structures with the use of local materials/resources as well as cost effective means. The Government has announced to rebuild all the damaged structures of the individuals, the public houses/infrastructures and the heritages devastated by the earthquake. in one year, two years and five years respectively. Such a scale of damage caused by the earthquake requires a huge fund.

The National Planning Commission (NPC) has recommended a low cost model of houses to the Government for necessary approval. Construction of houses in large scale as well as the construction of the collapsed government houses and the heritages requires a huge fund. So, the Government has decided to set up a National Reconstruction and Rehabilitation Fund (NRRF) with an initial target of collecting US$ 2 Billion. The Government has already transferred US$ 200.00 Million to the Fund as seed money. The Government has also urged the international community to make generous contributions to the Fund. Similarly, a Post Disaster Need Assessment (PDNA) is being conducted and the amount required for rehabilitation and reconstruction is expected to rise after the detailed assessment. A National Reconstruction Consultation Committee under the chairmanship of the Prime Minister has also been formed to

make the reconstruction campaign more effective and coordinated.
The Committee had its first meeting on 26 and 27 May 2015.

d. Priority Items:

The Government of Nepal issued an indicative list of priority items (that cover shelter, food, hygiene, clothes; drug and surgical items and construction; emergency veterinary medicines, vaccines, disinfectants and feeds; and agricultural nutrients) required in connection with the immediate relief operations. The list may be revised based on the evolving circumstances in the areas affected by the devastation. The last revision to the list was made on 14 May 2015 and was extended until 03 June 2015. The list is transmitted to all Diplomatic Missions, United Nations and its Specialized Agencies and other International Organizations based in Kathmandu for ready reference.

e. Injured in the Earthquake:

The Government initially decided to provide NPR 25,000.00 per injured person to the hospitals that are providing treatment facilities to the people injured in the earthquake. The Government will also provide money to the hospitals through the Ministry of Health and Population for treating more serious injuries. Later on, the Government decided to provide free of cost treatment facility for all the people injured in the earthquake. Similarly, the Government also decided to provide, as per a criterion to be worked out, additional relief to those left disabled due to the devastation.

f. Information Dissemination:

The Government has effectively disseminated, through different mediums of communication, all types of information for the safety, security and wellbeing of its citizens. The Government has warned that no one can predict the occurrences of earthquake, and therefore, has asked not to follow any rumor of earthquake prediction by some unscrupulous agents. Information on minimizing losses during the time and after earthquakes, safety tips, relief/rehabilitation measures taken by the Government, health and hygiene instructions, etc. is being constantly circulated. The websites of the Government agencies including those of the Nepalese missions abroad are now replete with the earthquake related information, and a dedicated portal http://www.drrportal.gov.np has been active to provide all types of information.

Relief Camp Management:

- The disaster-stricken areas are assisted from outside in returning to their proper level of functioning following the event.
- Type and quantity of relief supplies is determined by:
  - Type of disaster
  - Resources available
- In initial phase most important of these supplies are:
  - Health supplies to treat causalities
  - Resources to prevent communicable diseases
- Following these, other commodities viz. food, blankets, shelter, sanitary engineering etc comes second.
- Damage assessment to be carried out figure out the needs and resources available
- For managing the relief supplies principle components are:
  - Acquisition of the supplies
  - Transportation of these supplies
  - Storage of supplied materials

- Distribution

Planning of Relief:

- ❑ Management of medical Supply
- ❑ Assessment of immediate health needs
- ❑ Care and Shelter(Relief camps)
- ❑ Environmental management
    - Water supply
    - Basic Sanitation
    - Personal Hygiene
    - Vector control
- ❑ Food safety
- ❑ Clothing's & Utensils
- ❑ Disposal of dead

Epidemiologic surveillance and disease control:

- ❑ Increase of communicable diseases during disaster by:
    - Overcrowding and poor sanitation in temporary settlements.
    - Migration during emergency may introduce diseases to new areas either by man or by animals.
    - Disruption and damage to the water supply, sewerage and power systems
    - Diversion to relief work- disruption of routine control programmers'
    - Favorable ecology for breeding of vectors during disasters
    - Source of provision of food, water and shelter may itself be a source of infection.
- ❑ To combat communicable disease in emergency:
    - Implementation of all public health measures
    - Reliable disease reporting system to identify outbreaks and prompt control measures
    - Investigate all reports of disease outbreak.

Vaccination:

- ❑ WHO doesn't recommend typhoid and cholera vaccines use in routine care during disasters
- ❑ Compliance poor owing to multi-dosing
- ❑ Large number of workers engaged who otherwise could be utilized elsewhere.
- ❑ Supervision of sterilization & injection technique impossible.
- ❑ Mass vaccination may induce a false sense of security.
- ❑ Vaccination however is necessary for the health workers
- ❑ Best protection is maintenance of high level immunity in general population by RI before the disaster.

Nutrition:

- ❑ Disasters affects nutrition depending on type, duration, extends of disaster and preexisting nutritional condition.
- ❑ Infants, pregnant, lactating mothers, & sick more vulnerable.

INFORMATION TECHNOLOGY FOR REHABILITATION AND DECISION MAKING TOOLS:

Now in the age of technology it has been easier to manage the disasters both natural and men made. We can manage them by using the various features of information technology. IT is useful to prevent as well as recover them… It may be observed that advancement in Information Technology in the form of Internet, GIS, Remote Sensing, satellite communication, etc. can help a great deal in planning and implementation of hazards reduction measures. GIS can improve the quality and power of analysis of natural hazards assessments, guide development activities and assist planners in the selection of lessening measures and in the implementation of emergency preparedness and response action. Remote Sensing, on the other hand, as a tool can very effectively contribute towards identification of hazardous areas, monitor the planet for its changes on a real time basis and give early warning to many impending disasters. Communication satellites have become vital for providing emergency communication and timely relief measures. Integration of space technology inputs into natural disaster monitoring and mitigation mechanisms is critical for hazard reduction. It is absolutely necessary to create awareness amongst the public as well as decision makers for allocating resources for appropriate Investments in information technology. In this paper an attempt has been made to highlight the Role of information technology in management of natural disasters in India.

APPLICATION OF INFORMATION TECHNOLOGY IN DISASTER MANAGEMENT:

Though it is not possible to completely avoid the natural disasters, but the sufferings can be minimized by creating proper awareness of the likely disasters and its impact by developing a suitable warning system, disaster preparedness and management of disasters through application of information technology tools. The changing trends have opened up a large number of scientific and technological resources and skills to reduce disaster risk.

There are mainly applications we can use to manage disasters:

1) GIS and Remote Sensing
2) Internet

GIS AND REMOTE SENSING

GIS provides a tool for effective and efficient storage and manipulation of remotely sensed data and other spatial and non-spatial data types for both scientific management and policy oriented information. This can be used to facilitate measurement, mapping, monitoring and modeling of variety of data types related to natural phenomenon. The specific GIS application in the field of Risk Assessment are:- Hazard Mapping to show earthquake, landslides, floods or fire hazards. Theses map could be created for cities, districts or even for the entire country and tropical cyclone Threat Maps are used by meteorological departments to improve the quality of the tropical storm warning services and quickly communicate the risk to the people likely to get affected by the cyclone. Remote sensing makes observation of any object from a distance and without coming into actual contact. Remote sensing can gather data much faster than ground based observation, can cover large area at one time to give a synoptic view. Remote sensing comprises Aerial Remote Sensing which is the process of recording information, such as photographs and images from sensor on aircrafts and Satellite Remote Sensing which consists of several satellite remote sensing system which can be used to integrate natural hazard assessments into development planning studies. These are: Land sat, SPOT Satellite, Satellite Radar System, Advanced Very High Resolution Radio. Some applications of GIS and Remote Sensing in various disasters are as follows:-

(A)DROUGHT

GIS and Remote Sensing can be used in drought relief management such as early warnings of drought conditions will help to plan out the strategies to organize relief work. Satellite data may be used to target potential ground water sites for taking up well-digging programmers. Satellite data provides valuable tools for evaluating areas subject to desertification. Film transparencies, photographs and digital data can be used for the purpose of locating, assessing and monitoring deterioration of natural conditions in a given area.

(B)EARTHQUAKE

GIS and Remote Sensing can be used for preparing seismic hazards maps in order to assess the exact nature of risks.

(C)FLOODS

Satellite data can be effectively used for mapping and monitoring the flood inundated areas, flood damage assessment, flood hazard zoning and post flood survey of rivers configuration and protection works.