Disaster Mitigation and Management
Elective-II

UNIT-I

Introduction to Natural, human induced and human made disasters – Meaning, nature, types and effects; International decade of natural disaster reduction (IDNDR); International strategy of natural disaster reduction (ISDR)

Introduction

Importance of DMM in a country like India

- India is vulnerable in varying degrees to a large number of natural as well as man-made disasters.
- Further, the vulnerability to Nuclear, Biological and Chemical disasters and terrorism has also increased manifold.
- Disaster risks in India are further compounded by increasing vulnerabilities. These include:
- the ever growing population,
- the vast disparities in income,
- rapid urbanisation,
- increasing industrialisation,
- development within high-risk zones,
- Environmental degradation,
- Climate change, etc.

All these point to a future where disasters seriously threaten India's population, national security, economy and its sustainable development.

Need and importance

- As Indians we need to be aware of likely hazards and potential hazards, how, when and where they are likely to occur, and the problems which may result of an event.

Hazard profile of India

- 58% of the land mass susceptible - seismic hazard damage
- 12% of landmass - floods
- 68% of the total area – vulnerable to drought
- 7000 Km long coastline (8%) - threatened by cyclone
- Hilly regions- Avalanches/landslides/Hailstorms/cloudbursts
- 50% of the forest cover- forest fires
- other Human caused hazards

Definitions

Disaster

"is an event which is" –

- generally unpredictable
- happens instantly or without giving enough time to react
- affects a large number of people
- disrupting normal life leading to a large scale devastation in terms of loss of life and property
- Finds the administration and affected people struggling to respond in the desired manner
- leaves deep socio-psychological, political and economic after effects which persist for a long time to come.

Features

- Unpredictable
- Uncertain
- Unfamiliar
- Rapid
- Intense

Damages caused depends on

- geographical location
- Climate
- Degree of vulnerability
- Disaster: French word "Desastre" - 'des' meaning bad + 'aster' meaning star. Thus the term refers to 'Bad or Evil star'.
- "A serious disruption in the functioning of the community or a society causing wide spread- material, economic, social or environmental losses which exceed the ability of the affected society to cope using its own resources".
- hazard + vulnerability + insufficient capacity = disaster
- the economically disadvantaged
- racial and ethnic minorities
- the uninsured
- low-income children
- the elderly
- the homeless
- those with chronic health conditions, including severe mental illness

The vulnerability of these individuals is enhanced by race, ethnicity, age, sex and factors such as income, insurance coverage and absence of a usual source of care.

Their health and healthcare problems intersect with social factors, including housing, poverty, and inadequate education.

Vulnerability

- "The extent to which a community, structure, services or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrains or a disaster prone area."
- **Physical Vulnerability**: It is based on the physical condition of people and elements at risk, such as buildings, infrastructure etc; and their proximity, location and nature of the hazard.
- **Socio-economic Vulnerability**: It is based on the socioeconomic conditions. The socio-economic condition of the people also determines the intensity of the impact.

Risk

- Risk can be taken as chance or a probability that harm may occur.
- Risk is a function of the probability of particular hazardous event and the losses each would cause.
- The level of risk depends upon: Nature of the hazard vs Vulnerability of the elements which are affected vs Economic value of those elements
- A community/locality is said to be at 'risk' when it is exposed to hazards and is likely to be adversely affected by its impact.

Capacity

- Capacity can be defined as "resources, means and strengths which exist in households and communities and which enable them to cope with, withstand, prepare for, prevent, mitigate or quickly recover from a disaster".

Physical Capacity:

- Some family members have skills, which enable them to find employment if they migrate, either temporarily or permanently.

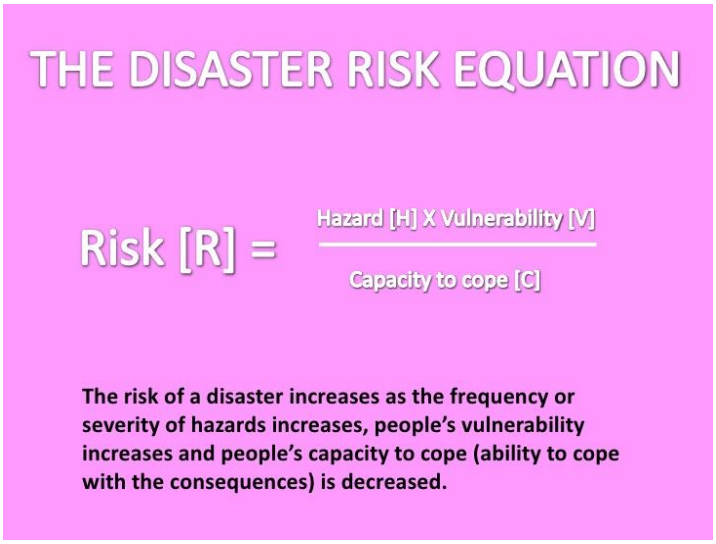
Socio-economic Capacity: In most of the disasters, people suffer their greatest losses in the physical and material realm.

Hazard Vs Disaster

- Hazards are always prevalent, but the hazard becomes a disaster only when there is greater vulnerability and less of capacity to cope with it.
- A hazard is a situation where there is a threat to life, health, environment or property.
- A disaster is an event that completely disrupts the normal ways of a community. It brings on human, economical, and environmental losses to the community which the community cannot bear on its own.
- Hazards are natural or manmade phenomenon that are a feature of our planet and cannot be prevented. In their dormant state, hazards just pose a threat to life and property.

- These hazards are termed as disasters when they cause widespread destruction of property and human lives. Once a hazard becomes active and is no longer just a threat, it becomes a disaster.
- We can prevent hazards becoming disasters if we learn to live in harmony with nature and take precautionary steps.

Variables such as Causes, Frequency, Duration of the Impact, Speed of Onset, and Scope of the Impact, Destructive Potential and Human Vulnerability etc determine the difference.



Types of disasters

- Natural, Man-made or Human-induced
- Disasters occur in varied forms
  - Some are predictable in advance
  - Some are annual or seasonal
  - Some are sudden and unpredictable
- Factors leading to a Disaster
  - Meteorological, Geological, Ecological or Environmental, Technological Etc.

Types	Hazards	
Geological Hazards	1. Earthquake 2. Tsunami 3. Volcanic eruption	4. Landslide 5. Dam burst 6. Mine Fire
Water & Climatic Hazards	1. Tropical Cyclone 2. Tornado and Hurricane 3. Floods 4. Drought 5. Hailstorm	6. Cloudburst 7. Landslide 8. Heat & Cold wave 9. Snow Avalanche 10. Sea erosion
Environmental Hazards Biological	1. Environmental pollutions 2. Deforestation 1. Human / Animal Epidemics 2. Pest attacks	3. Desertification 4. Pest Infection 3. Food poisoning 4. Weapons of Mass Destruction

Types	Hazards	
Chemical, Industrial and Nuclear Accidents	1. Chemical disasters 2. Industrial disasters	3. Oil spills/Fires 4. Nuclear
Accident related	1. Boat / Road / Train accidents / air crash Rural / Urban fires Bomb /serial bomb blasts 2. Forest fires	3. Building collapse 4. Electric Accidents 5. Festival related disasters 6. Mine flooding

Impacts of disaster on life, property and environment

- No. of deaths depends on the differences in the vulnerability and preparedness
- Increased deforestation- global warming, extreme weather conditions like floods, cyclones, tornadoes and droughts
- Risk for technological disasters
- Affects human health- outbreak of epidemics, communicable diseases
- Hazard to sanitation and drinking water systems
- Respiratory illness, inhalation of toxic gases
- Psychological effects
- People become shelterless

- **Disaster management** or **emergency management** is the creation of plans through which communities reduce vulnerability to hazards and cope with disasters.
- Disaster management does not prevent or eliminate the threats, instead it focuses on creating plans to decrease the impact of disasters.
- Failure to create a plan could lead to damage to assets, human mortality, and lost revenue.

Disaster Management can be divided into three parts:

- **Managing operations**: decision-making, information management, problem solving, project and program planning, resource management and monitoring
- **Managing organizations**: planning, control and direction, development, quality/performance control, physical control, communications and evaluation
- **Managing people**: leadership, organization, personnel management and monitoring.

Disaster Management Cycle

- Disaster Mitigation is a type of long-term, pre-disaster planning which involves repeated expenditures on structural and non-structural issues in an attempt to reduce or eliminate future risks.
- Mitigation in practice usually considers the medium or long term prospects of safety
- **Structural solutions** include engineered solutions such as redesigning buildings and designing physical barriers to disaster events to reduce damage.
- **Non-structural solutions** include social solutions such as early warning, evacuation planning, and emergency response preparedness.

- Disaster Risk Management includes sum total of all activities, programmes and measures which can be taken up before, during and after a disaster with the purpose to avoid a disaster, reduce its impact or recover from its losses. The three key stages of activities that are taken up within disaster risk management are:

1. Before a disaster (pre-disaster).

- Activities taken to reduce human and property losses caused by a potential hazard.
- carrying out awareness campaigns, strengthening the existing weak structures, preparation of the disaster management plans at household and community level etc.

2. During a disaster (disaster occurrence).

- Initiatives taken to ensure that the needs and provisions of victims are met and suffering is minimized. Activities taken under this stage are called emergency response activities.

3. After a disaster (post-disaster)

Initiatives taken in response to a disaster with a purpose to achieve early recovery and rehabilitation of affected communities, immediately after a disaster strikes. These are called as response and recovery activities.

Preparedness

- This protective process embraces measures which enable governments, communities and individuals to respond rapidly to disaster situations to cope with them effectively.

Preparedness includes -

- the formulation of viable emergency plans,
- the development of warning systems,
- the maintenance of inventories
- the training of personnel.
- embrace search and rescue measures
- evacuation plans for areas that may be at risk from a recurring disaster.

Preparedness therefore encompasses those measures taken before a disaster event which are aimed at minimising loss of life, disruption of critical services, and damage when the disaster occurs.

2. Mitigation

- Mitigation embraces measures taken to reduce both the effect of the hazard and the vulnerable conditions to it in order to reduce the scale of a future disaster. Therefore mitigation activities can be focused on the hazard itself or the elements exposed to the threat.
- Examples of mitigation measures which are hazard specific
- water management in drought prone areas,
- relocating people away from the hazard prone areas and
- by strengthening structures to reduce damage when a hazard occurs.
- In addition to these physical measures, mitigation should also aim at reducing the economic and social vulnerabilities of potential disasters

International Decade for Natural Disaster Reduction(IDNDR)

- In 1984, during the 8th World Conference on Earthquake Engineering in San Francisco, Dr. Frank Press proposed an International Decade for Natural Hazard Reduction.
- In 1987, the United Nations General Assembly passed a resolution calling for a Decade--International Decade for Natural Disaster Reduction (IDNDR, 1990-2000).

What is the need for IDNDR???

- To encourage people to protect communities from natural disasters.

The objective of IDNDR is to reduce, through concerted international action-

- the loss of life,
- property damage and
- social and economic disruption caused by natural disasters
- -such as earthquakes, tsunamis, floods, landslides, volcanic eruptions, droughts, and other disasters of natural origin especially in developing countries.

Mission

- "improve each United Nations (UN) member country's capacity to prevent or diminish adverse effects from natural disasters and to establish guidelines for applying existing science and technology to reduce the impact of natural disasters"

IDNDR Goals

- Improve each country's capacity to mitigate the effects of natural disasters
- Devise appropriate guidelines and strategies for applying existing scientific and technical knowledge
- Encourage scientific and engineering endeavors aimed at closing critical gaps in knowledge
- Disseminate existing and new technical information
- Develop measures for the assessment, prediction, prevention, and mitigation of natural disasters

IDNDR works through IDNDR National Committees and Focal Points, which exist in 138 countries. The IDNDR Secretariat is in Geneva, Switzerland.

- The IDNDR Scientific and Technical Committee is an advisory body of 25 experts from various fields from around the world.
- A UN Inter-Agency Standing Committee on IDNDR meets regularly, as well as a contact group of Geneva-based diplomatic missions. A Global Forum of

NGOs for Disaster Reduction was founded at the World Conference on Natural Disaster Reduction.

The IDNDR Programme Plan for 1997-2000 is built around five primary themes:

- Hazard, Vulnerability and Risk Assessment
- Early Warning Issues
- Disasters and Sustainable Development
- Political and Public Policy Commitment
- Shared Knowledge and Technology Transfer

- These themes serve to structure and focus an evaluation of the accomplishments of IDNDR, to assess remaining gaps, and to make proposals for concerted, effective application of disaster reduction strategies after the year 2000.
- The implementation of this plan is coordinated by the IDNDR Secretariat and implemented jointly through contributions of all partners in IDNDR.
- It was the first concerted effort for mankind to prevent the unnecessary loss of life from natural hazards.
- The decade provided a unique opportunity for the world community, in a spirit of global cooperation, to use the considerable existing scientific and technical knowledge to alleviate human suffering and enhance the security of sustainable societal and economic development.
- The decade greatly raised the public awareness; in particular, the awareness of governments of various countries.
- Fatalism is no longer acceptable and disaster could be reduced; governments have the responsibilities for security of their citizens, particularly from natural disasters.
- The decade once again proved that international and regional cooperation is extremely important for minimizing the losses during the disasters, in particular for developing countries.
- Decade taught the scientific and technical professionals that their roles in reducing natural disasters are especially important.
- Scientists and engineers have been playing significant roles in creating new knowledge, upgrading and applying existing knowledge, transferring effective technology to those at risk and educating people and governmental decision-makers in coping with potential disasters.
- Scientists and engineers working in the field of natural hazards further understand that all their activities are linking with minimizing the natural disasters.
- An integrated approach and all measures towards minimizing losses must be prepared before the occurrence of the disasters.
- Through the Decade, it has been proved that an integrated approach, including 4P (Planning, Prediction, Preparedness, and Prevention) and 4R

(Rescue, Relief, Recovering and Reconstruction), is extremely effective in reducing disasters.

- It is widely recognized that the objectives of IDNDR could not be fully reached through one Decade. However, the spirit of the Decade will last forever and under the light of the Decade scientists and engineers will dedicate themselves towards a much safer 21st Century.

NDR (Yokohama, May 1994)

- The World Conference on Natural Disaster Reduction (Yokohama, May 1994) was an important milestone in IDNDR's awareness-building process.
- It added socio-economic aspects as component of effective disaster prevention into perspective. It was recognized that social factors, such as cultural tradition, religious values, economic standing, and trust in political accountability are equally essential in the determination of societal vulnerability.
- The ability to address socio-economic factors requires knowledge and understanding of local conditions, which can – in most cases - only be provided by local people.
- A global strategy aiming at reducing the impacts of natural hazards therefore must include the development of national and sub-national mechanisms for disaster risk reduction.
- Within this context the IDNDR called on the UN-member states to establish National Platforms which would facilitate the adjustment of general disaster risk reduction objectives to national/local conditions, implement the agreed policies and expand the understanding and perception of the importance of disaster risk reduction on national levels.
- However, while some countries successfully established national networks many did not. Therefore there is a need to revitalize and strengthen these national structures.

Yokohoma Principles

1. Risk assessment is a required step
2. Disaster prevention and preparedness reduce the need for disaster relief.
3. Disaster prevention and preparedness are integral aspects of development policy and planning
4. Development and strengthening of capacities to prevent, reduce, and mitigate disasters is a top priority
5. Early warnings of impending disasters and their effective dissemination
6. Participation at all levels in prevention
7. Vulnerability reduction through proper design and patterns of development
8. Technology and information sharing
9. Environmental protection

10. Each country bears the primary responsibility for protecting its people, infrastructure, and other national assets from the impact of natural disasters

International Strategy for Disaster Reduction (ISDR)

- When IDNDR drew to an end, it was replaced and continued by the International Strategy for Disaster Reduction (ISDR).
- The ISDR aims to pursue the initiatives and cooperation agreed on during the IDNDR, and developing new mechanisms as well as pushing for further commitments from policy-makers.
- The overriding goal is to reduce human, social, economic and environmental losses due to natural hazards. The building of disaster resilient communities is a main objective.

Objectives

Recognizing that natural hazards can threaten any one of us, the ISDR builds on partnerships and takes a global approach to disaster reduction, seeking to involve every individual and every community towards the goals of reducing the loss of lives, the socio-economic setbacks and the environmental damages caused by natural hazards.

The ISDR promotes the following four objectives as tools towards reaching disaster reduction for all:

- Increase public awareness to understand risk, vulnerability and disaster reduction globally
- Obtain commitment from public authorities to implement disaster reduction policies and actions
- Stimulate interdisciplinary and inter-sectoral partnerships, including the expansion of risk reduction networks
- Improve scientific knowledge about disaster reduction

ISDR Mission

- Catalyze, facilitate and mobilize the commitment and resources of national, regional and international stakeholders of the ISDR System to build the resilience of nations and communities to disasters through the implementation of the Hyogo Framework for Action.

Hyogo Framework

- Governments around the world have committed to take action to reduce disaster risk, and have adopted a guideline to reduce vulnerabilities to natural hazards, called the **Hyogo Framework** for Action (HFA).

Hyogo goals

- Effective integration of disaster risk into sustainable development policies, planning, and programming
- The development and strengthening of institutions, mechanisms, and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience to hazards
- The systematic incorporation of risk reduction approaches into design and implementation of emergency preparedness, response, and recovery programs in the reconstruction of affected communities

Hyogo Priorities

- Ensuring that disaster risk reduction is a national and local priority with a strong institutional basis for implementation
- Identifying, assessing, and monitoring disaster risks and enhancing early warning
- Using knowledge, innovation, and education to build a culture of safety and resilience at all levels
- Reducing underlying risk factors
- Strengthening disaster preparedness for effective response at all levels

1. **Increase public awareness to understand risk, vulnerability and disaster reduction globally.**

   The more people, regional organizations, governments, non-governmental organizations, United Nations entities, representatives of civil society and others know about risk, vulnerability and how to manage the impacts of natural hazards, the more disaster reduction measures will be implemented in all sectors of society. Prevention begins with information.

2. **Obtain commitment from public authorities to implement disaster reduction policies and actions**

   The more decision-makers at all levels commit themselves to disaster reduction policies and actions, the sooner communities vulnerable to natural disasters will benefit from applied disaster reduction policies and actions. This requires, in part, a grassroots approach whereby communities at risk are fully informed and participate in risk management initiatives.

3. **Stimulate interdisciplinary and intersectoral partnerships, including the expansion of risk reduction networks**

The more entities active in disaster reduction share information on their research and practices, the more useful the global body of knowledge and experience will progress. By sharing a common purpose and through collaborative efforts we can ensure a world that is more resilient to the impact of natural hazards.

4. **Improve scientific knowledge about disaster reduction**

The more we know about the causes and consequences of natural hazards and related technological and environmental disasters on societies, the more we are able to be better prepared to reduce risks. Bringing the scientific community and policy makers together allows them to contribute to and complement each other's work.

Global Platform for Disaster Risk Reduction

- National practitioners and other stakeholders have repeatedly expressed the desire to have a mechanism through which they can exchange their experiences in disaster risk reduction and access information on how other countries addressed particular challenges in the implementation of the Hyogo Framework.
- The Global Platform has been set up to serve this need, and it is expected to become the main global forum for all parties involved in disaster risk reduction,

"namely governments, United Nations agencies, international financial institutions, regional bodies, civil society, the private sector, and the scientific and academic communities"

The Global Platform provides advocacy for effective action to reduce disaster risks, expands the political space devoted to the issue, and contributes to the achievement of the Millennium Development Goals particularly in respect to poverty reduction and environmental sustainability.

UN/ISDR

- The UN/ISDR is the focal point in the UN System to promote links and synergies between, and the coordination of, disaster reduction activities in the socio-economic, humanitarian and development fields, as well as to support policy integration.
- It serves as an international information clearinghouse on disaster reduction, developing awareness campaigns and producing articles, journals, and other publications and promotional materials related to disaster reduction.

The UN/ISDR headquarters is based in Geneva. It conducts outreach programmes through its regional units in Panama for the Americas, Nairobi for Africa, Cairo for Western Asia & North Africa.

UNIT-II

Natural Disasters– Hydrometeorological disasters: Causes, impacts, Early warning systems, structural and non-structural measures for floods, drought and cyclones; Tropical cyclones: Overview, cyclogenesis, drought monitoring and management.; Geographical based disasters: Earthquakes and Tsunami- Overview, causes, impacts, zoning, structural and non-structural mitigation measures; Tsunami generation; Landslides and avalanches: Overview, causes, impacts, zoning and mitigation measures. Case studies related to various hydrometeorological and geographical based disasters.

Hydrometeorological disasters

1. Floods

"Flood is a state of high water level along a river channel or on the coast that leads to inundation of land, which is not usually submerged"

Causes:

- Flooding may occur as an overflow of water from water bodies, such as a river or lake in which the water overtops or breaks levees resulting in some of that water escaping its usual boundaries.
- Floods can also occur in rivers when the flow rate exceeds the capacity of the river channel, particularly at bends or meanders in the waterway.
- Some floods develop slowly, while others such as flash floods, can develop in just a few minutes and without visible signs of rain.
- Floods can happen on flat or low-lying areas when the ground is saturated and water either cannot run off or cannot run off quickly enough to stop accumulating.
- Floods can also occur if water falls on an impermeable surface, such as concrete, paving or frozen ground, and cannot rapidly dissipate into the ground.

Types of floods:

Areal Flash floods

Localised heavy rain from a series of storms moving over the same area can cause areal flash flooding when the rate of rainfall exceeds the drainage capacity of the area.

Riverine

River flows may rise to floods levels at different rates, from a few minutes to several weeks, depending on the type of river and the source of the increased flow.

Estuarine and coastal

Flooding in estuaries is commonly caused by a combination of sea tidal surges caused by winds and low barometric pressure, which can be associated by high upstream river flow.

Coastal areas may be flooded by storm events at sea, resulting in waves over-topping defences or in severe cases by tsunami or tropical cyclones

Urban flooding

Urban flooding is the flooding of land or property in a built environment, particularly in more densely populated areas, caused by rainfall overwhelming the capacity of drainage systems, such as storm sewers.

Catastrophic

Catastrophic flooding is usually associated with major infrastructure failures such as the collapse of a dam, but they may also be caused by damage sustained in an earthquake or volcanic eruption.

Effects:

- Loss of life, damage to buildings and other structures, including bridges, sewerage systems, roadways, and canals.
- Damage to roads and transport infrastructure
- Floods also frequently damage power transmission
- Leads to loss of drinking water treatment and water supply. It may also cause the loss of sewage disposal facilities.
- Lack of clean water combined with human sewage in the flood waters raises the risk of waterborne diseases.
- Flood waters typically inundate farm land, making the land unworkable and preventing crops from being planted or harvested.
- Economic hardship due to a temporary decline in tourism, rebuilding costs, or food shortages leading to price increases is a common after-effect of severe flooding.
- The impact on those affected may cause psychological damage to those affected, in particular where deaths, serious injuries and loss of property occur.

Remedies:

In many countries around the world, waterways prone to floods are often carefully managed.

- Defenses such as detention basins, levees, bunds, reservoirs, and weirs are used to prevent waterways from overflowing their banks.
- Emergency measures such as sandbags or portable inflatable tubes are often used to try and stem flooding.
- In the riparian zone near rivers and streams, erosion control measures can be taken to try and slow down or reverse the natural forces that cause many waterways to meander over long periods of time.
- Flood controls, such as dams, can be built and maintained over time to try and reduce the occurrence and severity of floods as well.
- In areas prone to urban flooding, one solution is the repair and expansion of man-made sewer systems and storm water infrastructure.
- Another strategy is to reduce impervious surfaces in streets, parking lots and buildings through natural drainage channels, porous paving, and wetlands.
- Areas identified as flood-prone can be converted into parks and playgrounds that can tolerate occasional flooding.
- Ordinances can be adopted to require developers to retain stormwater on site and require buildings to be elevated, protected by floodwalls and levees, or designed to withstand temporary inundation.

Distributional Pattern of Floods in India

- Floods occur in almost all the river basins of the country. Around 12 per cent (40 million hectare) of land in India is prone to floods.
- Our country receives an annual rainfall of 1200 mm, 85% of which is concentrated in 3-4 months i.e June to September.
- Due to the intense and periodic rain, most of the rivers of the country are fed with huge quantity of water, much beyond their carrying capacity.
- The Ganga basin, Brahmaputra basin, the north-western river basin (Jhelum, Chenab, Ravi, Sutlej, Beas), peninsular river basin (Tapti, Narmada, Mahanadi, Baitarani, Godavari, krishna, Pennar and the Kaveri) and the coastal regions of Andhra Pradesh, Tamilnadu, orissa and Kerela.
- Assam, Uttar Pradesh, Bihar and Orissa are some of the states who have been severely prone to floods.

Warning

- With the advancement of technology such as satellite and remote-sensing equipments flood waves can be tracked as the water level rises.
- Except for flash floods there is usually a reasonable warning period.
- Heavy precipitation will give sufficient warning of the coming river flood.

- High tides with high winds may indicate flooding in the coastal areas. Evacuation is possible with suitable monitoring and warning.
- Warning is issued by the Central Water Commission (CWC), Irrigation & Flood Control Department, and Water Resources Department.
- CWC maintains close liaison with the administrative and state engineering agencies, local civil authorities to communicate advance warning for appropriate mitigation and preparedness measures.

Risk reduction measures

- **Mapping of the flood prone areas** is a primary step involved in reducing the risk of the region. Historical records give the indication of the flood inundation areas and the period of occurrence and the extent of the coverage.
- Warning can be issued looking into the earlier marked heights of the water levels in case of potential threat.
- In the coastal areas the tide levels and the land characteristics will determine the submergence areas. Flood hazard mapping will give the proper indication of water flow during floods.
- **Land use control** will reduce danger of life and property when waters inundate the floodplains and the coastal areas.
- In areas where people already have built their settlements, measures should be taken to relocate to better sites so as to reduce vulnerability.
- No major development should be permitted in the areas which are subjected to high flooding.
- Important facilities like hospitals, schools should be built in safe areas. In urban areas, water holding areas can be created like ponds, lakes or low-lying areas.
- **Construction of engineered structures** in the flood plains and strengthening of structures to withstand flood forces and seepage.
- The buildings should be constructed on an elevated area. If necessary build on stilts or platform.

Flood Control aims to reduce flood damage.

- Decreasing the amount of runoff with the help of reforestation, protection of vegetation, clearing of debris from streams and other water holding areas, conservation of ponds and lakes etc.
- Flood Diversion include levees, embankments, dams and channel improvement.
- Dams can store water and can release water at a manageable rate. But failure of dams in earthquakes and operation of releasing the water can cause floods in the lower areas. Flood Proofing reduces the risk of damage.
- Measures include use of sand bags to keep flood water away, blocking or sealing of doors and windows of houses etc. Houses may be elevated by

building on raised land. Buildings should be constructed away from water bodies.

Flood Management in India

- Systematic planning for flood management commenced with the Five Year Plans, particularly with the launching of National Programme of Flood Management in 1954.
- During the last 48 years, different methods of flood protection structural as well as nonstructural have been adopted in different states depending upon the nature of the problem and local conditions.
- Structural measures include storage reservoirs, flood embankments, drainage channels, anti-erosion works, channel improvement works, detention basins etc. and non-structural measures include flood forecasting, flood plain zoning, flood proofing, disaster preparedness etc.
- The flood management measures undertaken so far have provided reasonable degree of protection to an area of 15.81 million hectares throughout the country.

Some tools used as a part of flood control measures include:

- Maps become the common element in terms of identification of flood-prone areas, identifying the risk to individuals and institutions, preparation of emergency response plans, and design of flood protection and flood proofing measures.
- Perhaps their greatest value is as an educational and communication tool and they should be readily available to the public as well as to emergency response agencies at all levels of government.
- Through modern computational systems, inundation maps can be generated in real-time and be part of the hydrological forecast system. These can greatly assist in communication to residents in areas of potential risk, and in planning response actions and assistance.
- Policies and programmes to keep future flood damages from rising are based on the delineation and mapping of flood-prone areas.
- Such programmes are needed to curb the rising social and economic losses that results from floods. Alternate use of flood-prone land should be considered where possible.
- It is better to have the land zoned and used for purposes such as parks, nature areas or ecological reserves than to try and ensure that future development is flood proofed.
- Climatological or seasonal forecasting has now advanced to the point of being a useful tool in reducing the risk of flooding.
- This information can then be used to increase the degree of readiness of emergency response and forecasting agencies.

- In certain cases the climatic forecasts can also be used to increase the availability of storage in reservoirs, to influence water management decisions and to create an awareness of the potential for flooding.
- When the probability of the extreme flooding event is greater than normal, then activities such as the stockpiling of sandbags, emergency food and water supplies, and the evacuation of high value stored crops or goods from floodprone areas can be undertaken.
- It is a good time to create awareness in the public as to the potential for flooding, highlight the actions that the public and others should take, and to carry out emergency response exercises to test the degree of readiness.

Supportive Technologies

- A number of tools are available to array and display information for the use of technical experts, to explain programmes of flood damage reduction to the decision-makers, and to communicate real time forecasts and warnings to the public.
- In general the tools should be interactive in the sense that the information can be easily updated, and flexible enough to develop scenarios, and to provide visual and quantitative information regarding the state of conditions during the forecasted event.
- Geographic Information Systems (GIS) provide a computer-based information and manipulation system useful in support of flow forecasting and emergency response. layers of utility, land use, flood plain delineation, and structures information can help in the development and updating of emergency response plans.
- A good representation of the basin topography is an important asset in flood forecasting, emergency action and mitigation. A digital elevation model (DEM) or digital terrain model (DTM) for the basin should be developed as part of any GIS.
- DEM is constructed from whatever topographic information is available. Parts of the basin or certain features may be very accurate while others may be quite basic. The DEM can be improved with time.
- The development of inexpensive global position indicators has made GIS information easier to obtain.
- Three dimensional displays, zoom and scan, and rotational techniques can be combined with other informational material such as pictures, overheads or slides.
- As an example, a GIS flood inundation map can be generated based on hydraulic model derived information. The map can be conveyed to residents in the flood plain and is useful for depicting the probable impact of the approaching flood.

- This tailoring of technical information into displays that are more readily understood is valuable for explaining programmes to decision-makers, informed experts, and the public at large.

2. Droughts

A drought is a period of unusually dry weather that persists long enough to cause environmental or economic problems, such as crop damage and water supply shortages. A drought can last for months or years.

- Drought is either absence or deficiency of rainfall from its normal pattern in a region for an extended period of time leading to general suffering in the society.
- Drought is a normal, recurrent feature of climate. Drought can occur by improper distribution of rain in time and space, and not just by its amount.
- Drought is negative balance between precipitation and water use in a geographical region.
- It is a slow on-set disaster and it is difficult to demarcate the time of its onset and the end. The effects of drought accumulate slowly over a considerable period of time.

Causes:

- Drought is an extended period when a region notes a deficiency in its water supply whether surface or underground water.
- Generally, this occurs when a region receives consistently below average precipitation.
- Generally, rainfall is related to the amount and dew point of water vapour carried by regional atmosphere, combined with the upward forcing of the air mass containing that water vapour. If these combined factors do not support precipitation volumes sufficient to reach the surface, the result is a drought.
- Human activities can directly trigger exacerbating factors such as over farming, excessive irrigation, deforestation, and erosion adversely impact the ability of the land to capture and hold water.
- Activities resulting in global climate change are expected to trigger droughts with a substantial impact on agriculture throughout the world, and especially in developing nations.

Effects:

Periods of droughts can have significant environmental, agricultural, health, economic and social consequences.

- Diminished crop growth or yield productions and carrying capacity for livestock
- Dust storms, when drought hits an area suffering from desertification and erosion
- Famine due to lack of water for irrigation
- Habitat damage, affecting both terrestrial and aquatic wildlife.
- Hunger, drought provides too little water to support food crops.
- Malnutrition, dehydration and related diseases
- Mass migration, resulting in internal displacement and international refugees
- Reduced electricity production due to reduced water flow through hydroelectric dams.
- Shortages of water for industrial users.
- War over natural resources, including water and food

Types of droughts:

1. **Meteorological drought** is brought about when there is a prolonged period with less than average precipitation. Meteorological drought usually precedes the other kinds of drought.
2. **Agricultural droughts** are droughts that affect crop production or the ecology of the range. This condition can also arise independently from any change in precipitation levels when soil conditions and erosion triggered by poorly planned agricultural endeavors cause a shortfall in water available to the crops.
3. **Hydrological drought** is brought about when the water reserves available in sources such as aquifers, lakes and reservoirs fall below the statistical average. Hydrological drought tends to show up more slowly because it involves stored water that is used but not replenished.
4. **Socio-economic drought -** correlates the supply and demand of goods and services with the three above-mentioned types of drought. When the supply of some goods or services such as water and electricity are weather dependant then drought may cause shortages in supply of these economic goods.

Strategies for drought protection, mitigation or relief include:

- Dams - many dams and their associated reservoirs supply additional water in times of drought.
- Cloud seeding - a form of intentional weather modification to induce rainfall.
- Desalination - of sea water for irrigation or consumption.

- Drought monitoring - Continuous observation of rainfall levels and comparisons with current usage levels can help prevent man-made drought.
- Land use - Carefully planned crop rotation can help to minimize erosion and allow farmers to plant less water-dependent crops in drier years.
- Outdoor water-use restriction - Regulating the use of sprinklers, hoses or buckets on outdoor plants, filling pools, and other water-intensive home maintenance tasks.
- Rainwater harvesting - Collection and storage of rainwater from roofs or other suitable catchments.
- Recycled water - Former wastewater (sewage) that has been treated and purified for reuse.
- Transvasement - Building canals or redirecting rivers as massive attempts at irrigation in drought-prone areas.

Elements at risk

- All those elements that are primarily dependent on water are most affected.
- It affects the rain fed crops and then slowly creeps into the irrigated crops.
- People who are dependent on agriculture and areas where the other livelihood opportunities are least developed are greatly affected.
- The herdsman, landless labourer, subsistence farmers, women, children and farm animals are the most vulnerable groups.

Identifying Drought

The following criteria have been set by the Indian Meteorological Division (IMD) for identifying the drought.

- Onset of drought: Deficiency of a particular year's rainfall exceeding 25 percent of normal.
- Moderate drought: Deficit of rainfall between 26-50 percent of normal.
- Severe drought: Deficit of rainfall more than 50 percent of normal.

Indian Droughts

Large parts of the Indian subcontinent are prone to occurrence of droughts – their frequency, intensity and impact varying greatly with the geographic area affected. Aberrations in the total volume and pattern of rains from south-west monsoon are primarily responsible for droughts in the region-recent studies indicating EL Nino Phase of southern oscillation (ENSO) having strong impact on droughts in India. Arid and semi-arid regions with little or no development of irrigation facilities are by far the worst affected due to droughts. Droughts cause misery to both human and livestock population, accelerate degradation of natural resources and put a heavy pressure on government's resources through relief measures. There are strong links between poverty and proneness of an area to drought. Widespread crop failures

leading to acute shortages of food and fodder adversely affecting human and livestock health and nutrition, scarcity of drinking water accentuated by deteriorating ground water quality and declining water tables leading to large scale migration are the major manifestation of droughts.

Drought distribution pattern of India

- Around 68% of India's total area is drought prone to drought.
- 315 out of a total of 725 Talukas in 99 districts are drought prone.
- 50 million people are annually affected by drought.
- Arid and semi-arid regions with little or no development of irrigation facilities are by far the worst affected due to droughts.
- Large scale migration from western Rajasthan towards Gujarat, Haryana, Punjab, Uttar Pradesh and Madhya Pradesh in search of fodder, food, work and water were experienced in drought years that imposed severe hardships to the desert dwellers and resulted in large scale livestock casualties.
- As the water storage in the region is dependent on the scanty rainfall, the duration of availability of water in surface water reservoirs gets reduced drastically in drought years. During drought years, shallow wells dry up fast and deep wells become deeper. The quality of groundwater deteriorates and the concentration of undesirable constituents e.g. fluoride and nitrate often reach toxic levels.
- Drought, differs from any other natural disaster. As the meteorological drought turns into hydrological drought, the impacts start appearing first in agriculture which is most dependant on the soil moisture. Irrigated areas are affected much later than the rainfed areas.

The impacts slowly spread into social fabric as

- the availability of drinking water diminishes,
- reduction in energy production,
- ground water depletion,
- food shortage,
- health reduction and loss of life,
- increased poverty, reduced quality of life and
- social unrest leading to migration.

<u>Risk reduction measures</u>

- **Public Awareness and education:** This includes awareness on the availability of safe drinking water, water conservation techniques, agricultural drought management strategies like crop contingency plans, construction of rain water harvesting structure. Awareness can be generated by the print, electronic and folk media.

- **Drought Monitoring:** It is continuous observation of the rainfall situation, availability of water in the reservoirs, lakes, rivers etc and comparing with the existing water needs in various sectors of the society.
- **Water supply augmentation and conservation** through rainwater harvesting in houses and farmers' fields increases the content of water available. Water harvesting by either allowing the runoff water from all the fields to a common point (e.g. Farm ponds, see the picture) or allowing it to infiltrate into the soil where it has fallen (insitu) (e.g. contour bunds, contour cultivation, raised bed planting etc) helps increase water availability for sustained agricultural production.
- **Expansion of irrigation** facilities reduces the drought vulnerability. **Land use** based on its capability helps in optimum use of land and water and can avoid the undue demand created due to their misuse.
- **Livelihood planning** identifies those livelihoods which are least affected by the drought. Some of such livelihoods include increased off-farm employment opportunities, collection of non-timber forest produce from the community forests, raising goats, carpentry etc.
- **Drought planning:** the basic goal of drought planning is to improve the effectiveness of preparedness and response efforts by enhancing monitoring, mitigation and response measures.
- This would help in effective coordination among state and national agencies in dealing with the drought.

Components of drought plan include-

- establishing drought taskforce which the government is taking decision to deal with drought situation
- establishing coordination mechanism among various agencies which deal with the droughts
- providing crop insurance schemes to the farmers to cope with the drought related crop losses and
- public awareness generation.

Agricultural insurance schemes

- Pradhan Mantri Fasal Bima Yojana
- Comprehensive Crop Insurance Scheme
- Experimental Crop Insurance
- Farm Income Insurance Scheme
- National Agriculture Insurance Scheme

Drought management in India

To mitigate/overcome the adverse effects of droughts and to combat desertification, the government of India has pursued strategies and implemented several development programmes over the past 2-3 decades. These programmes include Drought Prone Area Programme initiated in 1973-74, Desert Development Programme started in 1977-78, National Watershed Development Programme in rainfed areas, started in 1990 etc. In addition, the country has effectively responded to drought situations in several parts over the past 3-4 decades.

- India is a signatory to the UN Convention to Combat Desertification, and is now developing an Action Plan based on experiences gained through the past programme and keeping in view the objectives and elements of UN Conference in the framework of Agenda 21.
- This will call for new and innovative ways of generating and promoting technology options which take into account the social and economic conditions of people involved, use bottom-up approaches by involving people in decision making, take into account the vast indigenous knowledge base and adopt integrated farming system approaches in arriving at solutions to the complex problems.

Drought Prone Area Program (1974)

- The intent was to change DPAP from a relief and employment oriented program into 'drought proofing' through adoption of an integrated area development approach which sought to mitigate the impact of future droughts by stabilizing both production and employment under prevailing conditions of erratic rainfall.
- The program emphasized on investments to benefit the poorer section of rural population and the govt included a number of subsidies.
- The program's main thrust was to restore ecological balance of the area through optimal utilization of land, water, livestock and human resources.
- The key objective was the promotion of appropriate land use practices including farm forestry and horticulture for more productive rainfed agriculture on the basis of available soil and water resources and agroclimatic conditions.

Accordingly, the program aimed to concentrate on -

- soil and water conservation,
- water harvesting practices,
- afforestation and farm forestry,
- livestock development including development of pasture and fodder resources and

- promotion of diversified production and employment possibilities e.g., through horticulture, sericulture etc.
- Progress of program achievements is provided in qualitative terms e.g. irrigation potential created, aggregate areas on soil water conservation, area covered by forestry and pasture development etc.

Desert Development Program (DDP)

- The objectives of this program started in 1977-78 were

"to control desertification, restore the ecological balance of desert and semi-desert areas and create conditions for raising the level of production, income and employment of the population of these areas".

- These objectives were sought to be achieved by means of-
- afforestation with emphasis on shelter belt plantation,
- grassland development and sand dune stabilization
- conservation and optimal utilization of groundwater
- construction of water harvesting structure
- development of agriculture, horticulture and animal husbandry and dairy.

- The two programs were reviewed by a committee, which submitted a report in 1994. The report asserts that ecological degradation has continued to proceed unabated resulting from reduced forest cover, depletion of groundwater, reduced availability of fodder and fuel wood.
- Clearly, the programs failed to neutralize the adverse impact of process of degradation on account of increased population pressure and poverty on the already stressed fragile ecosystems.
- Notwithstanding the general lack of impact of the programs, there were exceptions.
- In a few isolated cases where interventions were made on sound watershed based plans and participation of local communities was ensured, the adverse impacts of drought were considerably reduced and a reversal of the degradation process was apparent.
- The report observed that if beneficiaries were not involved right from the beginning they remained unmotivated to assume the responsibility for maintenance after the works were completed even when the benefits accruing from such works were substantial.

3. Cyclones

- Cyclone is a region of low atmospheric pressure surrounded by high atmospheric pressure resulting in swirling atmospheric disturbance.
- This is accompanied by powerful winds blowing in anticlockwise direction in the Northern Hemisphere and in the clockwise direction in the Southern Hemisphere.
- They occur mainly in the tropical and temperate regions of the world.

Cyclones are known by different names

- Typhoons - the Northwest Pacific Ocean west of the dateline
- Hurricanes - the North Atlantic Ocean, the Northeast Pacific Ocean east of the dateline, or the South Pacific Ocean.
- Tropical cyclones - the Southwest Pacific Ocean and South-east Indian Ocean.
- Severe cyclonic storm (the North Indian Ocean) & Tropical cyclone (the South-west Indian Ocean)
- Willie-Willie - Australia
- Tornado - South America

General Characteristics of cyclones

- Cyclones in India are moderate in nature. Some of the general characteristics of a cyclone are:
- 1. Strong winds
- 2. Exceptional rains
- 3. Storm surge

Cyclones are generally accompanied by strong winds which cause a lot of destruction. In some cases it is accompanied by heavy downpour and also the rise in the sea which intrudes inland there by causing floods.

Development of a cyclone

The development of a cyclone covers **three** stages namely

a) Formation and initial development state:

- Four atmospheric/ oceanic conditions are necessary for the formation of a cyclone namely:
- A warm sea temperature in excess of 26 degree centigrade, to a depth of 60 meters, which provides abundant water vapour in the air by evaporation.
- High relative humidity of the atmosphere to a height of about 7000 meters, facilitates condensation of water vapor into droplets and clouds, releases heat energy and induces drop in pressure.
- Atmospheric instability encourages considerable vertical cumulus cloud convection when condensation of rising air occurs.

- A location of at least 4-5 latitude degrees from the Equator allow the influence of the force due to the earth's rotation to take effect in inducing cyclonic wind circulation around low pressure centers.

b) Fully matured:

- The main feature of a fully mature tropical cyclone is a spiral pattern of highly turbulent giant cumulus thundercloud bands. These bands spiral inwards and form a dense highly active central cloud core which wraps around a relatively calm zone. This is called the **"eye"** of a cyclone. The eye looks like a black hole or a dot surrounded by thick clouds. The outer circumference of the thick cloud is called the **'eye wall'.**

c) Weakening or decay:

A tropical cyclone begins to weaken as soon as its source of warm moist air is abruptly cut off. This is possible when the cyclone hits the land, or the cyclone moves to a higher altitude or when there is interference of another low pressure.

- Depending on their track on the warm tropical sea and proximity to land a cyclone may last for less than 24 hours to more than 3 weeks. On an average the life cycle of a cyclone (a cyclone to complete these three stages mentioned above) takes six days.
- The longest cyclone is typhoon John which lasted for 31 days (August to September, 1994 in the north east and north west pacific basins).

Elements at Risk

- Strong winds, torrential rains and flooding cause a huge loss to life and property.
- The 1999 Super Cyclone of Orissa killed more than 10,000 precious lives with women and children greatly affected.
- Apart from loss to life there is a huge loss to infrastructures like houses built of mud, older buildings with weak walls, bridges, settlements in low lying areas.

Indian Cyclones

- Cyclones vary in frequency in various parts of the world.
- The 7516.6 kms long Indian coastline is the earth's most cyclone battered stretch of the world.
- Around 8 percent of the total land area in India is prone to cyclones.
- About two-third of the cyclones that occur in the Indian coastline occur in the Bay of Bengal.
- The states which are generally affected in the east coast – West Bengal, Orissa, Andhra Pradesh, Tamil Nadu and on the west coast Gujarat, Maharashtra, Goa, Karnataka and Kerala.

Cyclone Warning

- Low pressure and the development can be detected hours or days before it causes damage. The satellites track the movement of these cyclones based on which the people are evacuated from areas likely to be affected.
- It is difficult to predict the accuracy. Accurate landfall predictions can give only a few hours' notice to threatened population.
- India has one of the best cyclone warning systems in the world. The India Meteorological Department (IMD) is the nodal department for wind detection, tracking and forecasting cyclones.
- Cyclone tracking is done through INSAT satellite. Cyclone warning is disseminated by several means such as satellite based disaster warning systems, radio, television, telephone, fax, high priority telegram, public announcements and bulletins in press.
- These warnings are disseminated to the general public, the fishing community especially those in the sea, port authorities, commercial aviation and the government machinery.

Typical adverse effects

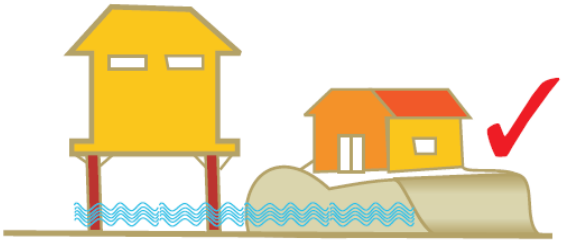
- High winds cause major damage to infrastructure and housing. They are generally followed by heavy rains and floods and, in flat coastal areas by inundating the land over long distances of even upto 15 kilometer inland.
- Physical damage – structures will be damaged or destroyed by the wind force, flooding and storm surge. Light pitched roofs of most structures especially the ones fitted on to industrial buildings will suffer severe damage.
- Casualties and public heath – caused by flooding and flying elements, contamination of water supplies may lead to viral outbreaks, diarrhea, and malaria.
- Water supplies – Ground and pipe water supply may get contaminated by flood waters.
- Crops and food supplies – high winds and rains ruin the standing crop and food stock lying in low lying areas. Plantation type crops such as banana and coconut are extremely vulnerable. Salt from the sea water may get deposited on the agricultural land and increase the salinity. The loss of the crop may lead to acute food shortage.
- Communication – severe disruption in the communication links as the wind may bring down the electricity and communication towers, telephone poles, telephone lines, antennas and satellite disk and broadcasting services.
- Transport lines (road and rail) may be curtailed, Lack of proper communication affects effective distribution of relief materials.

Possible Risk Reduction Measures

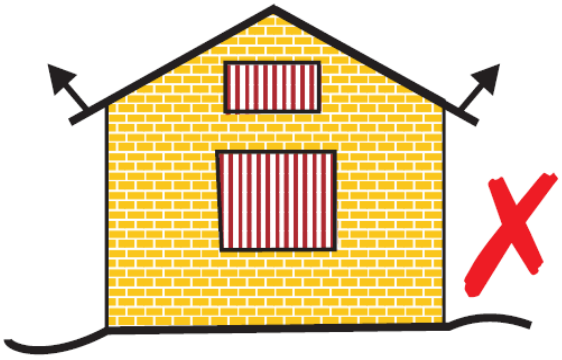
- **Coastal belt plantation -** green belt plantation along the coastal line in a scientific interweaving pattern can reduce the effect of the hazard. Providing a cover through green belt sustains less damage. Forests act as a wide buffer zone against strong winds and flash floods.
- Without the forests the cyclone travel freely inland. The lack of protective forest cover allows water to inundate large areas and cause destruction. With the loss of the forest cover each consecutive cyclone can penetrate further inland.
- **Hazard mapping** – Meteorological records of the wind speed and the directions give the probability of the winds in the region. Cyclones can be predicted several days in advance. The onset is extensive and often very destructive. Past records and paths can give the pattern of occurrence for particular wind speeds.
- A hazard map will illustrate the areas vulnerable to cyclone in any given year. It will be useful to estimate the severity of the cyclone and various damage intensities in the region. The map is prepared with data inputs of past climatological records, history of wind speed, frequency of flooding etc.
- **Land use control** should be designed so that least critical activities are placed in vulnerable areas. Location of settlements in the flood plains is at utmost risk.
- Siting of key facilities must be marked in the land use. Policies should be in place to regulate land use and building codes should be enforced.

- **Engineered structures** – Structures need to be built to withstand wind forces. Good site selection is also important. Majority of the buildings in coastal areas are built with locally available materials and have no engineering inputs. Good construction practices should be adopted such as:
- It is advised to construct on stilts or on earth mound.
- Houses can be strengthened to resist wind and flood damage.
- All elements holding the structures need to be properly anchored to resist the uplift or flying off of the objects.
- For example, avoid large overhangs of roofs, and the projections should be tied down.
- A row of planted trees will act as a shield. It reduces the energy.
- Buildings should be wind and water resistant.
- Buildings storing food supplies must be protected against the winds and water.
- Protect river embankments.
- Communication lines should be installed underground.
- Provide strong halls for community shelter in vulnerable locations.

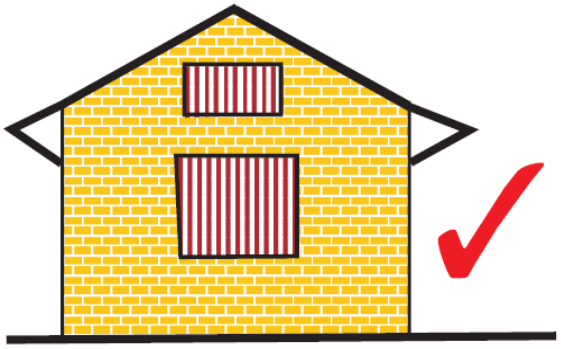
Construction at ground level –risk of inundation



If natural elevation is not available construction on stilts or on artificially raised earth mounds



Large overhangs get lifted and broken.



For large overhangs, use ties.

- **Flood management** – Torrential rains, strong wind and storm range leads to flooding in the cyclone affected areas. There are possibilities of landslides too. Flood mitigation measures could be incorporated.
- **Improving vegetation cover** – The roots of the plants and trees keep the soil intact and prevent erosion and slow runoff to prevent or lessen flooding. The use of tree planted in rows will act as a windbreak. Coastal shelterbelt plantations can be developed to break severe wind speeds. It minimizes devastating effects.
- The Orissa calamity has also highlighted the need for urgent measures like shelterbelt plantation along cyclone-prone coastal areas.
- Species chosen for this purpose should not only be able to withstand the impact of strong cyclonic winds, but also check soil erosion.

Super-cyclones

- A rapidly-rotating storm system characterised by spiral arrangement of thunderstorms rains, a low-pressure centre, strong winds, is known as a super cyclone.
- They form over large bodies of warm water, deriving their energy from water evaporation from the surface of the ocean.
- This water re-condenses into clouds and rain when moist air rises and cools to saturation.

Orissa super cyclone- Case study

- 29th October 1999, Super-cyclone with wind speed of 260-300 km/hour hit the 140 km coast of Orissa with a storm surge created in the Bay-of-Bengal with water level 9 metres higher than normal.
- It was the strongest tropical cyclone ever recorded in the North Indian Ocean. It was also the deadliest tropical cyclone in the Indian Ocean and deadliest Indian storm since 1971.
- It was a tropical depression formed over the Malay Peninsula on October 25. It moved to the northwest and became a tropical storm on October 26. It continued to strengthen into a cyclone on October 27. On October 28, it became a severe cyclone with a peak of 160 mph (260 km/h) winds. It hit India the next day as a 155 mph (250 km/h) cyclone. It caused the deaths of about 10,000 people, and heavy to extreme damage in its path of destruction.
- The superstorm travelled more than 260 km inland and within a period of 36 hrs ravaged more than 200 lakh hectares of land, devouring trees and vegetation, leaving behind a huge trail of destruction.
- The violent cyclone was merciless and broke the backbone of Orissa's economy and killed thousands and devastated millions.
- Tens of thousands of families from the coastal districts were forced to evacuate their homes before the storm's arrival.
- The cyclone dumped heavy torrential rain over southeast India, causing record breaking flooding in the low-lying areas. The storm surge destroyed 17,110 km^2
- Approximately 275,000 homes were destroyed leaving 1.67 million people homeless. A total of 9,803 people officially died from the storm.
- The number of domestic animals fatalities was around 2.5 million. The high number of domestic animal deaths may have possibly had to do with around 5 million farmers losing their livelihood.
- The damage across fourteen districts in India resulted from the storm was approximately $4.5 billion (1999 USD, $5.1 billion 2005 USD).

Aftermath

- Indian Red Cross Society immediately responded with emergency relief. The Odisha state branch extended the emergency relief phase to a three-month relief operation and a six-month rehabilitation program with the help of the Federation.
- The overall humanitarian response spanned well into the late 2000. The Odisha State Branch (OSB) immediately shipped emergency buffer stocks from the Indian Red Cross headquarters in New Delhi.
- They dispatched about 2,340 volunteers to 84 villages greatly affected by the storm. Efforts were taken to adopt and to rebuild the villages.

- A total of 200 concrete homes were constructed, as well as two concrete schools and two village tube-wells. The project was finally completed in May 2002, two and a half years after the cyclone hit.
- As of October 30, 1999, 50,000 people were evacuated from low-lying flooded areas by the Odisha Government.

Coastal belt plantations

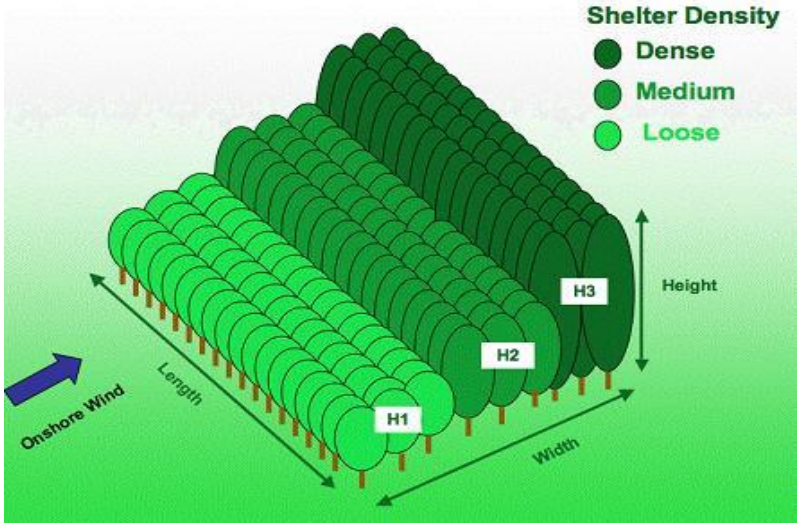
- Apart from the various cyclone mitigation measures, the need to take up shelterbelt plantation was given one of the priorities.
- Coastal Shelter-belts creates a live barrier for a strong current of wind thereby provide protection to agriculture crops during normal times and mitigate likely effect of cyclones on life, property infrastructure in the region.
- The MOEF, GOI under the scheme of Integrated Afforestation and Eco-development Project Scheme (IAEPS), had taken up afforestation activity in the coastal area with suitable tree species to form a shelterbelt along the coast line to mitigate the impact of strong cyclonic winds and thus checking soil erosion and inward sand drift.
- Bio-shields formed by planting a vegetation belt along coastlines would protect India against future coastal storms, cyclones and tsunamis. The plantations could play a double role. While absorbing the force of severe storms and tsunamis, the 'bio-shield' could act as a 'carbon sink' by absorbing emissions of the greenhouse gas carbon dioxide.
- Another key recommendation is to help local communities build artificial coral reefs, among which fish could shelter and breed. They also have a very important role stabilizing and trapping marine sediments and forming a protective buffer between the land and the sea

Species used as coastal belt plantations

- Casuarina
- Anacardium occidentale
- Acacia planifrons
- Ficus benghalensis
- Madhuca longifolia

- Casuarina equisetifolia is the most popular farmforestry tree in the coastal lands of Andhra pradesh, Orissa, Tamilnadu, West Bengal, Maharashtra, Gujarat & Karnataka.
- Casuarina resembles feathery conifer in general appearance. Almost all of the approximately 35 casuarina species produce top-quality firewood.
- They are rapid-growing, can grow any where at any site and climates as varied as coastal sand dunes, high mountain slopes, the hot humid tropics and semi-arid regions. They tend to be salt tolerant, wind resistant and adaptable to moderately poor soils.

- Though casuarina in an attractive option for planting in the coastal landscapes, the mixed species approach, especially using native species, should be encouraged taking community needs into account.
- Apart from the species the length and breadth of the shelterbelts also should be discussed with the community. Linking educational institutions in this process can help youth to get involved in this important endeavor by bringing together academic learning and social responsibility.



Geographical based disasters

4. Earthquakes

Earthquakes are sudden violent movement of the earth's surface and tectonic plates of the ocean which may cause great damage. Tectonic plates are pieces of the Earth's crust and uppermost mantle, together referred to as the lithosphere. The shaking or trembling caused by the sudden release of energy usually associated with faulting or breaking of rocks continuing adjustment of position results in aftershocks.

The point within Earth where faulting begins is the focus, or hypocenter. The point directly above the focus on the surface is the epicenter

- Seismic waves are waves of energy that travel through the Earth's layers, and are a result of an earthquake, explosion, or a volcano that gives out low-frequency acoustic energy.
- Two types of waves:
  - Body waves
    - P and S
  - Surface waves
    - R and L

- Body waves
  - P or primary waves
    - fastest waves
    - travel through solids, liquids, or gases
    - compressional wave, material movement is in the same direction as wave movement
  - S or secondary waves
    - slower than P waves
    - travel through solids only
    - shear waves - move material perpendicular to wave movement
- Surface Waves
  - Travel just below or along the ground's surface
  - Slower than body waves; rolling and side-to-side movement
  - Especially damaging to buildings

~80% of all earthquakes occur in the circum-Pacific belt

- most of these result from convergent margin activity
- ~15% occur in the Mediterranean-Asiatic belt
- remaining 5% occur in the interiors of plates and on spreading ridge centers
- more than 1,50,000 quakes strong enough to be felt are recorded each year

How are the Size & Strength of an Earthquake Measured?

- Intensity
  - subjective measure of the kind of damage done
  - people's reactions to it
  - isoseismal lines identify areas of equal intensity
- Magnitude
  - Richter scale measures total amount of energy released by an earthquake; independent of intensity
  - Amplitude of the largest wave produced by an event is corrected for distance and assigned a value on an open-ended logarithmic scale

Earthquake Precursors

- changes in elevation or tilting of land surface,
- fluctuations in groundwater levels,
- magnetic field,
- electrical resistance of the ground

Several key factors that contribute to vulnerability of human populations to earthquakes:

- Location of settlements in an earthquake prone area, especially on soft ground, on area prone to landslides or along fault lines.
- Dense collection of weak buildings with high occupancy.
- Non-engineered buildings constructed by earth, rubble, buildings with heavy roofs, poor quality and maintenance of buildings
- Weak or flexible storey intending for parking purposes.

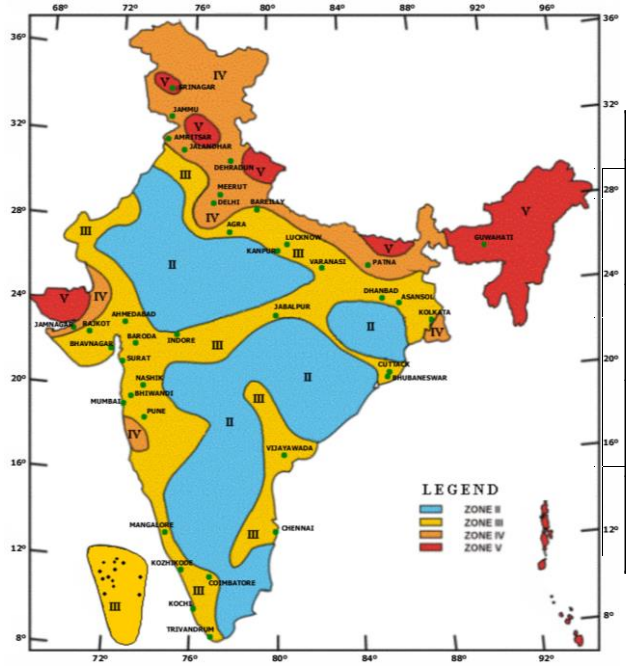
Indian earthquakes

- The Indian subcontinent lies upon the Indian Plate.
- This plate is moving northward at about 5 cms per year and in doing so, collides with the Eurasian Plate.
- Upon the Eurasian Plate lie the Tibet plateau & Central Asia.
- Due to this collision, the Himalayas are thrust higher and many earthquakes are generated in the process.
- This is the cause of earthquakes from the Himalayas to the Arakan Yoma.
- The same process, results in earthquakes in the Andaman & Nicobar Islands.
- Sometimes earthquakes of different magnitudes occur within the Indian Plate, in the peninsula and in adjoining parts of the Arabian Sea or the Bay of Bengal.
- These arise due to localized systems of forces in the crust sometimes associated with ancient geological structures.
- All earthquakes in peninsula India falls within this category.

Hazard zones of India

- As per the latest seismic zoning map of India the country is divided into four Seismic Zones.
- Zone V marked in red shows the area of Very High Risk Zone
- Zone IV marked in orange shows the area of High Risk Zone
- Zone III marked in yellow shows the region of Moderate Risk Zone
- Zone II marked in blue shows the region of Low risk Zone.
- Zone V is the most vulnerable to earthquakes, where historically some of the country's most powerful shock has occurred.
- Zone V - Geographically this zone includes the Andaman & Nicobar Islands, all of North-Eastern India, parts of north-western Bihar, eastern sections of Uttaranchal, the Kangra Valley in Himachal Pradesh, near the Srinagar area in Jammu & Kashmir and the Rann of Kutchh in Gujarat.
- Earthquakes with magnitudes in excess of 7.0 have occurred in these areas, and have had intensities higher than IX.
- Much of India lies in Zone III, where a maximum intensity of VII can be expected.
- New Delhi lies in Zone IV whereas Mumbai and Chennai lie in Zone III.

All states and UTs across the country have experienced earthquakes.



Zone	Magnitude
Zone V	Very High Risk Quakes of Magnitude ***8*** and greater
Zone IV	High Risk Quakes upto Magnitude ***7.9***
Zone III	Moderate Risk Quakes upto Magnitude ***6.9***
Zone II	Seismic Disturbances upto Magnitude ***4.9***

Source: IS 1893 (Part 1) : 2002 (BIS)

MSK Scale

- The **Medvedev–Sponheuer–Karnik scale**, also known as the **MSK** or *MSK-64*, is a macroseismic intensity scale used to evaluate the severity of ground shaking on the basis of observed effects in an area of the earthquake occurrence.
- The scale was first proposed by Sergei Medvedev (USSR), Wilhelm Sponheuer (East Germany), and Vít Kárník (Czechoslovakia) in 1964. It was based on the experiences being available in the early 1960s from the application of the Modified Mercalli scale and the 1953 version of the Medvedev scale, known also as the GEOFIAN scale.
- Intensity is a qualitative measure of the actual shaking at a location during an earthquake, and is notated in a roman capital numeral.
- The MSK scale is more convenient for application in field and is widely used in India.
- The zoning criterion of the map is based on likely intensity. The scale range from I (least perceptive) to XII (most severe).
- The intensity scales are based on three features of shaking – perception by people, performance of buildings, and changes to natural surroundings.

- The seismic zoning map broadly classifies India into zones where one can expect earthquake shaking of the more or less the same maximum intensity.
-

Zone	Area liable to shaking intensity	Description *(Arrangement in paragraphs of scale as follows: i) Persons and surroundings, ii) Structures of all kinds, iii) Nature)*
II	VI (and lower)	**VI Frightening** i) Felt by most indoors and outdoors. Many people in buildings are frightened and run outdoors. A few persons loose their balance. Domestic animals rum out of their stalls. In many instances, dishes and glassware may break, and books fall down, pictures move, and unstable objects overturn. Heavy furniture may possibly move and small steeple bells may ring. ii) Damage of Grade 1*** is sustained in single** buildings of Type B* and in many** of Type A*. Damage in some buildings of Type A is of Grade 2***. iii) Cracks up to widths of 1cm possible in wet ground; in mountains occasional landslips: change in flow of springs and in level of well water are observed.
III	VII	**VII Damage of Buildings** i) Most people are frightened and run outdoors. Many find it difficult to stand. The vibration is noticed by persons driving motor cars. Large bells ring. ii) In many buildings of Type C* damage of Grade 1 is caused; in many buildings of Type B damage is of Grade 2. Most** buildings of Type A suffer damage of Grade 3***, few of Grade 4***. In single instances, landslides of roadway on steep slopes: crack in roads; seams of pipelines damaged; cracks in stone walls. iii) Waves are formed on water, and is made turbid by mud stirred up. Water levels in wells change, and the flow of springs changes. Some times dry springs have their flow resorted and existing springs stop flowing. In isolated instances parts of sand and gravelly banks slip off.
IV	VIII	**VIII Destruction of buildings** i) Fright and panic; also persons driving motor cars are disturbed, Here and there branches of trees break off. Even heavy furniture moves and partly overturns. Hanging lamps are damaged in part. ii) Most buildings of Type C suffer damage of Grade 2, and few of Grade 3, Most buildings of Type B suffer damage of Grade 3. Most buildings of Type A suffer damage of Grade 4. Occasional breaking of pipe seams. Memorials and monuments move and twist. Tombstones overturn. Stone walls collapse. iii) Small landslips in hollows and on banked roads on steep slopes; cracks in ground up to widths of several centimeters. Water in lakes becomes turbid. New reservoirs come into existence. Dry wells refill and existing
V	IX (and higher)	**IX General damage of buildings** i) General panic; considerable damage to furniture. Animals run to and fro in confusion, and cry. ii) Many buildings of Type C suffer damage of Grade 3, and a few of Grade 4. Many buildings of Type B show a damage of Grade 4 and a few of Grade 5. Many buildings of Type A suffer damage of Grade 5. Monuments and columns fall. Considerable damage to reservoirs; underground pipes partly broken. In individual cases, railway lines are bent and roadway damaged. iii) On flat land overflow of water, sand and mud is often observed. Ground cracks to widths of up to 10 cm, on slopes and river banks more than 10 cm. Further more, a large number of slight cracks in ground; falls of rock, many land slides and earth flows; large waves in water. Dry wells renew their flow and existing wells dry up.
		X General Destruction of Buildings **XI Destruction** **XII Landscape Changes**

*a) Type of Structures (Buildings)

Type A - Building in field-stone, rural structures, unburnt-brick houses, clay houses.

Type B - Ordinary brick buildings, buildings of large block and prefabricated type, half timbered structures, buildings in natural hewn stone.

Type C - Reinforced buildings, well built wooden structures.

**b) Definition of Quantity

Single	Few - About 5 percent	**Many**	About 50 percent	**Most**	About 75 percent

*** Classification of Damage to buildings

Grade 1	Slight damage	Fine cracks in plaster; fall of small pieces of plaster
Grade 2	Moderate damage	Small cracks in walls; fall of fairly larger pieces of plaster; pantiles slip off; cracks in chimneys parts of chimney fall down.
Grade 3	Heavy damage	Large and deep cracks in walls; fall of chimneys.
Grade 4	Destruction	Gaps in walls; parts of buildings may collapse; separate parts of the buildings lose their cohesion; and inner walls collapse.
Grade 5	Total damage	Total collapse of the buildings

Effects

- *Physical Damage* – damage or loss of buildings and service structures. Fires, floods due to dam failures, landslides could occur.
- *Casualties* – often high, near to the epicenter and in places where the population density is high (say, multistoried buildings) and structures are not resistant to earthquake forces.
- *Public health* – multiple fracture injuries, moderately and severely injured is the most widespread problem, breakdown in sanitary conditions and large number of casualties could lead to epidemics.
- *Water supply* – severe problems due to failure of the water supply distribution network and storage reservoirs. Fire hydrants supply lines if vulnerable could hamper fire service operations.
- *Transport network* – severely affected due to failure of roads and bridges, railway tracks, failure of airport runways and related infrastructure.
- *Electricity and Communication* – all links affected. Transmission towers, transponders, transformers collapse.

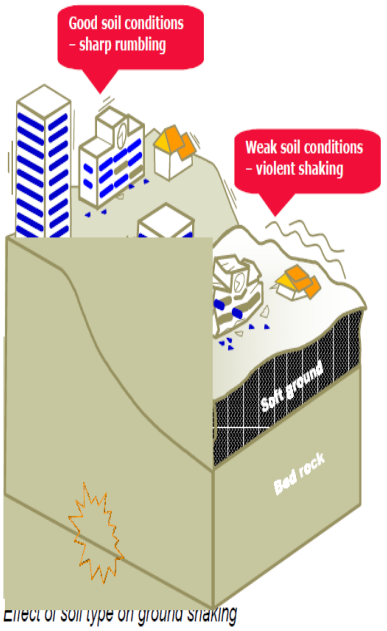
Mitigation measures

- ***Engineered structures*** (designed and built) to withstand ground shaking.
- Architectural and engineering inputs put together to improve building design and construction practice.
- Analyze soil type before construction and do not build structures on soft soil.
- Buildings built on soft soils are more likely to get damaged even if the earthquake is not particularly strong in magnitude. Similar problem persists in the alluvial plains and conditions across the river banks. Heavy damages are concentrated when ground is soft.

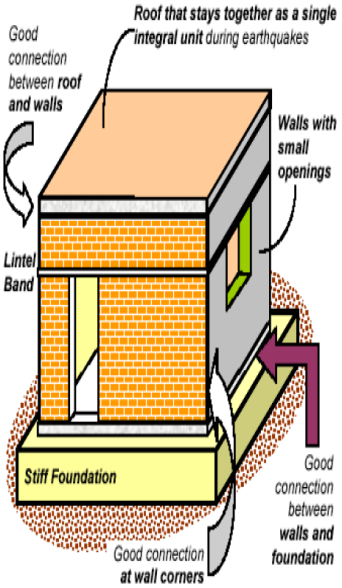
- To accommodate on weak soils adopt safety measures in design and Follow ***Indian Standard Codes*** for construction of buildings.
- Enforcement of the ***Byelaws*** including ***Land use*** control and restriction on density and heights of buildings
- ***Strengthening*** of important lifeline buildings which need to be functional after a disaster.
- Upgrade level of safety of hospital, fire service buildings etc.
- ***Public awareness***, sensitization and training programmes for *A*rchitects, *B*uilders, *C*ontractors, *D*esigners, *E*ngineers, *F*inanciers, *G*overnment functionaries, *H*ouse owners, *M*asons etc.
- Reduce possible damages from secondary effects such as - fire, floods, landslides etc. e.g. identify potential landslide sites and restrict construction in those areas.

Community based mitigation

- **Community preparedness** along with public education is vital for mitigating the earthquake impact. Earthquake drillsCas and Public awareness programme.
- **Community based Earthquake Risk Management Project** should be developed and sustainable programmes launched.
- Retrofitting of schools and important buildings, purchase of emergency response equipment and facilities, establishing proper insurance can be the programmes under Earthquake Risk Management Project.
- A large number of local masons and engineers will be trained in disaster resistant construction techniques.



Effect of soil type on ground shaking



Essential requirements in a Masonry building

Case study- Gujarat Bhuj earthquake

- The **2001** on 26 January, India's 52nd Republic Day, at 08:46 AM local time an earthquake occurred and lasted for over two minutes. The epicentre was about 9 km south-southwest of the village of Chobari in Kutch District of Gujarat, India.
- The earthquake reached 7.7 on the magnitude scale and had a maximum felt intensity of X (*Intense*) on the Mercalli intensity scale.
- The earthquake killed around 20,000 people injured another 167,000 and destroyed nearly 400,000 homes.

Tectonic setting

- Gujarat lies about 400 km from the plate boundary between the Indian Plate and the Eurasian Plate, but the current tectonics is still governed by the effects of the continuing continental collision along this boundary.
- During the collision with Eurasia the area has undergone shortening, involving both reactivation of the original rift faults and development of new low-angle thrust faults.
- The related folding has formed a series of ranges, particularly in central Kutch.
- The 2001 Gujarat earthquake was caused by movement on a previously unknown south-dipping fault, trending parallel to the inferred rift structures.

Effects

- The final death toll in Kutch was 12,300. Bhuj was totally devastated.
- Considerable damage also occurred in Bhachau and Anjar with hundreds of villages flattened in Taluka of Anjar, Bhuj & Bhachau.
- Over a million structures were damaged or destroyed, including many historic buildings and tourist attractions.
- The quake destroyed around 40% of homes, eight schools, two hospitals and 4 km of road in Bhuj. In Ahmedabad, as many as 50 multi-storied buildings collapsed and several hundred people were killed.
- Total property damage was estimated at $5.5 billion.
- In Kutch, the quake destroyed about 60% of food and water supplies and around 2,58,000 houses - 90% of the district's housing stock.
- The biggest setback was the total demolition of the Bhuj Civil hospital. The Indian military provided emergency support which was later augmented by the International Federation of Red Cross and Red Crescent Society.
- A temporary Red Cross hospital remained in Bhuj to provide care while a replacement hospital was built.

5. Tsunami

- Tsunami is a series of water waves caused by the displacement of a large volume of a body of water. It is a Japanese word meaning "harbour wave".
- These waves originate from undersea or coastal seismic activity, landslides, and volcanic eruptions.
- 26th December, 2004, a massive earthquake of Magnitude 9.0 hit Indonesia generating Tsunami waves in South-east Asia & eastern coast of India.
- Height of tsunami waves ranged from 3 – 10 m affecting a total coastal length of 2260 km in the states of Andhra Pradesh, Tamil Nadu, Kerala & UTs of Pondicherry, Andaman & Nicobar Islands.
- Tsunami waves travelled up to a depth of 3 km from the coast, killing more than 10,000 people & affected more than lakh of houses leaving behind a huge trail of destruction.
- If the earthquake or under water land movement is near the coast then tsunami may strike suddenly.
- If the earth movement is far in the sea then it may take few minutes to hours before striking the coast.
- The onset is extensive and often very destructive.

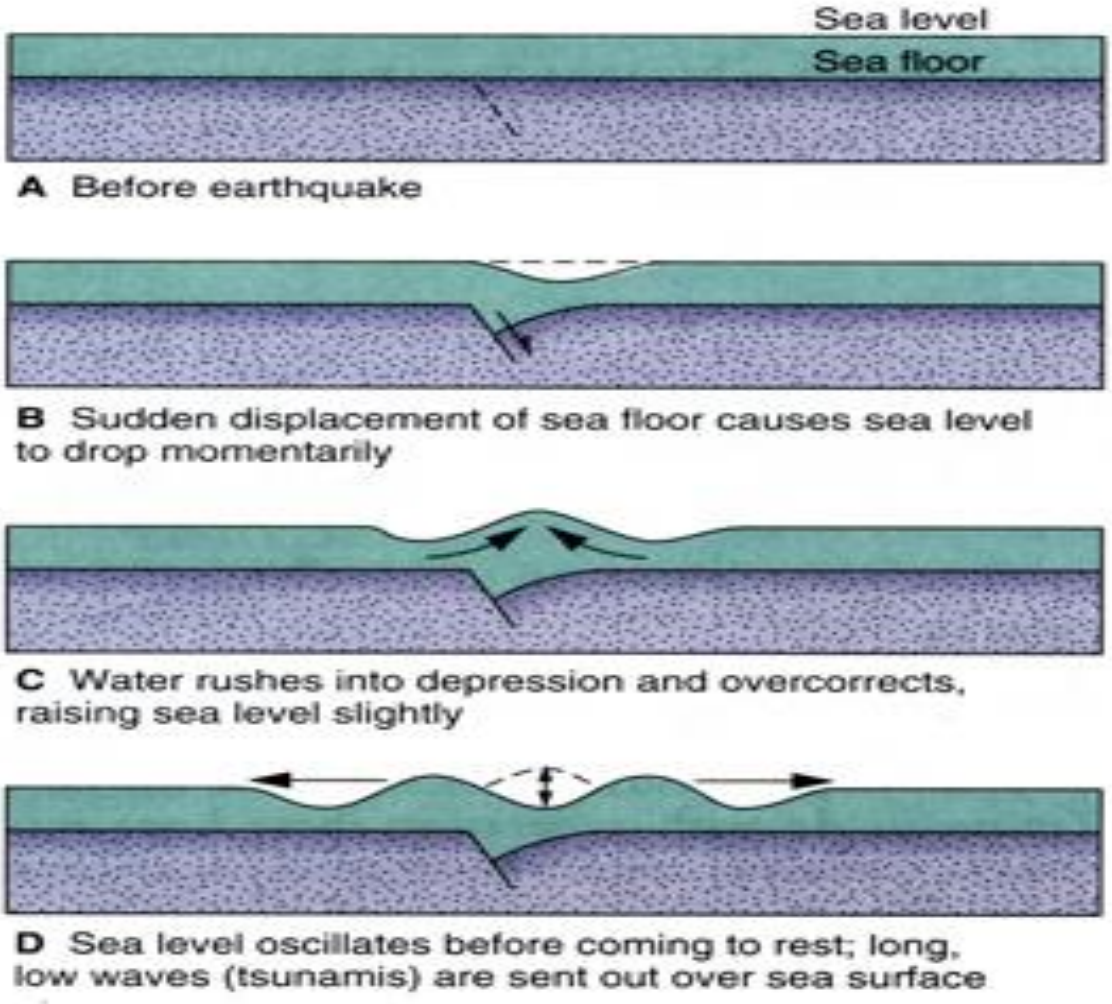
Why does this happen?

- When an earthquake occurs, the energy travels outward in all directions.
- For the epicentre, the energy causes a sea wave to move away at great speed.
- Tsunami can be generated when the sea floor abruptly deforms and vertically displaces the overlying water.

Causes

The general causes of Tsunamis are geological movements.
It is produced in *three major ways*.

- The most common of these is fault movement on the sea floor, accompanied by an ***earthquake***.
- The second most common cause of tsunamis is a ***landslide*** either occurring underwater or originating above the sea and then plunging into the water.
- The third major cause of tsunamis is ***volcanic activity***. The flank of a volcano, located near the shore or underwater, may be uplifted or depressed similar to the action of a fault. Or, the volcano may actually explode.
- Tsunamis are caused by events that drastically and suddenly shift a large volume of water.



Tsunami waves differs from ordinary ocean waves, which are produced by wind blowing over water. The tsunamis travel much faster than ordinary waves. Compared to normal wave speed of 100 kilometers per hour, tsunami in the deep water of the ocean may travel the speed of a jet airplane - 800 kilometers per hour. And yet, in spite of their speed, tsunami increases the water height only 30-45cm and often passes unnoticed by ships at sea. As wave gets into shallow water, bottom of wave drags along ocean floor. Top of wave still moving fast: can cause cresting of wave, and breaking onto shore.

Warnings

- Tsunami is not a single giant wave. It consists of ten or more waves - a "tsunami wave train". Studies of past historical tsunamis indicate where tsunamis are most likely to be generated, their potential heights, and flooding limits at specific coastal locations. With use of satellite technology it is possible to provide nearly immediate warnings of potentially tsunamigenic

earthquakes.

- Warning time depends upon the distance of the epicenter from the coast line. The warning includes predicted times at selected coastal communities where the tsunami cold travel in a few hours.

Elements at risk

- All structures located within 200 m of the low lying coastal area are most vulnerable to the direct impact of the tsunami waves as well as the impact of debris & boulders brought by it.
- Settlements in adjacent areas will be vulnerable to floods.
- Structures constructed of wood, mud, thatch, sheets and structures without proper anchorage to foundations are liable to be damaged by tsunami waves & flooding.
- Other elements at risk are infrastructure facilities like ports & harbours, telephone and electricity poles, cables.
- Ships & fishing boats/nets near the coast also add to the destruction caused by tsunami waves

Effects

- **Physical damage** - Local tsunami events or those less than 30 minutes from the source cause the majority of damage. The force of can raze everything in its path. It is the flooding effect of a tsunami, however, that most greatly effects human settlements by water damage to homes and businesses, roads, bridges and other infrastructure. Ships, port facilities, boats/trawlers, fishing nets also get damaged.
- **Environmental damage** - The range varies from generation of tonnes of debris on account of structural collapse of weaker buildings, release of toxic chemicals into the environment on account of chemical leak/spillage/process failure/utility breakages/ collateral hazards and negative impact on the already fragile ecosystems.
- **Casualties and public health**- Deaths occur principally from drowning as water inundates homes or neighbourhoods. Many people may be washed out to sea or crushed by the giant waves. There may be some injuries from battering by debris and wounds may become contaminated.
- **Water supply**: sewage pipes may be damaged causing major sewage disposal problems. Drinking water shortage arises due to breakage of water mains and

contamination. Open wells and ground water may become unfit for drinking due to contamination of salt water and debris.

- **Standing Crops and food supplies**: flooding by tsunami causes damage to the standing crops and also to the food supplies in the storage facilities. The land may be rendered infertile due to salt water incursion from the sea.

Specific preparedness and mitigation measures

- **Hazard mapping** – a hazard map should be prepared with designated areas expected to be damaged by flooding by tsunami waves. Historical data could be of help in showing areas inundated in the past. Keeping in mind the vulnerable areas, evacuation routes should be constructed and mapped. The plan should be followed by evacuation drill.

- **Early warning systems** – a well networked system in place can warn the communities of the coastal areas when the threat is perceived. Tsunami warning should be disseminated to local, state, national as well as the international community so as to be prepared as they are capable of crossing across continents. The information can be broadcasted to the local emergency officers and the general public. On receiving of the warning the action should be to evacuate the place as decided in the evacuation plan.

- **Community Preparedness** – communities in the coastal areas are faced by storm surge and tsunami waves. It is important that the community is better prepared to take suitable actions on receiving of the threat and follow emergency evacuation plans and procedures.

- **Site Planning and Land Management**- site planning determines the location, configuration, and density of development on particular sites and is, therefore, an important tool in reducing tsunami risk.

- The designation and zoning of tsunami hazard areas for such open-space uses as agriculture, parks and recreation, or natural hazard areas is recommended as the first land use planning strategy. This strategy is designed to keep development at a minimum in hazard areas.

- In areas where it is not feasible to restrict land to open-space uses, other land use planning measures can be used. These include strategically controlling the type of development and uses allowed in hazard areas, and avoiding high-value and high-occupancy uses to the greatest degree possible. The capital improvement planning and budgeting process can be used to reinforce land use planning policies.

- **Engineering structures** – As most of the structures along the coast area

comprises of fisherman community, which are constructed of lightweight materials without any engineering inputs. Therefore there is an urgent need to educate the community about the good construction practices that they should adopt such as--

- **Site selection –** Avoid building or living in buildings within several hundred feet of the coastline as these areas are more likely to experience damage from tsunamis.
- Construct the structure on a higher ground level with respect to mean sea level.
  Elevate coastal homes: Most tsunami waves are less than 3 meters in height. Elevating house will help reduce damage to property from most tsunamis. Structural columns resist the impact while other walls are expendable. It is important to also take note that adequate measures are also brought into the design to cater for earthquake forces.
- Construction of water breakers to reduce the velocity of waves.
- Use of water & corrosion resistant materials for construction.
- Construction of community halls at higher locations, which can act as shelters at the time of a disaster.
- **Flood management** - Flooding will result from a tsunami. Flood mitigation measures could be incorporated. Building barriers or buffers such as special breakwaters or seawalls can be an effective risk reduction measure against gushing waters in case of Tsunami/Storm surge during cyclones.

Tsunami Detection and early warning system

- In 1995 the US National Oceanic and Atmospheric Administration (NOAA) began developing the Deep Ocean Assessment and Reporting of Tsunami (DART) system. By 2001 six stations had been deployed in the Pacific Ocean.
- Each station consists of a sea bed bottom pressure recorder (at a depth of about 6000 m) which detects the passage of a tsunami and transmits the data to a surface buoy. The surface buoy then radios the information to the PTWC. There are two distinct types of tsunami warning:
  a) **International tsunami warning systems:**
     Shortly after the Hilo Tsunami (1946), the Pacific Tsunami Warning System (PTWS) was developed with its operational center at the Pacific Tsunami Warning Center (PTWC) near Honolulu, Hawaii. The PTWC is able to alert countries several hours before the tsunami strikes. The warning includes predicted arrival time at selected coastal communities where the tsunami could travel in few hours. A tsunami watch is issued with subsequent arrival time to other geographic areas.
  b) **Regional Warning Systems:**
     These use seismic data about nearby earthquakes to determine if there is a possible local threat of a tsunami. Such systems are capable enough

to provide warnings to the general public in less than 15 minutes.

DART system for Tsunami

What is a deep-ocean tsunami detection buoy?

Deep-ocean tsunami detection buoys are used by the Bureau of Meteorology (Bureau) to confirm the existence of tsunami waves generated by undersea earthquakes. These buoys observe and record changes in sea level out in the deep ocean.

How does a deep-ocean tsunami detection buoy work?

- A typical tsunami buoy system comprises two components;
- the pressure sensor anchored to the sea floor
- the surface buoy.
- The sensor on the sea floor measures the change in height of the water column above by measuring associated changes in the water pressure. This water column height is communicated to the surface buoy by acoustic telemetry and then relayed via satellite to the tsunami warning centre.
- The tsunami buoy is triggered when the pressure sensor first detects the faster moving seismic wave moving through the sea floor. It then commences reporting sea level information at one minute intervals to enable rapid verification of the possible existence of a tsunami.

Indian Scenario

- **Indian National Center for Ocean Information Services** (**INCOIS**) is an autonomous organization of the Government of India, under the Ministry of Earth Sciences,, Hyderabad. ESSO-INCOIS was established as an autonomous body in 1999 under the Ministry of Earth Sciences (MoES) and is a unit of the Earth System Science Organization (ESSO). ESSO- INCOIS is mandated to provide the best possible ocean information and advisory services to society, industry, government agencies and the scientific community through sustained ocean observations and constant improvements through systematic and focussed research.
- In India, the **Survey of India** maintains a tide gauge network along the coast of India. The gauges are located in major ports.
- The day-to-day maintenance of the gauge is carried with the assistance from authorities of the ports. Apart from the tide gauge, tsunami can be detected with the help of radars.
- The 2004 Indian Ocean tsunami, recorded data from four radars and recorded the height of tsunami waves two hours after the earthquake.
- The satellites observations of the Indian Ocean tsunami would not have been of any use in delivering warnings, as the data took five hours to process and it was pure chance that the satellites were overhead at that time. However, in future it is possible that the space-based observation might play a direct role in tsunami warning.

Tsunami preparedness measures

If you feel an earthquake that lasts 20 seconds or longer when you are on the coast; Drop, cover, and hold on. You should first protect yourself from the earthquake. When the shaking stops, gather your family members and evacuate quickly. Leave everything else behind. A tsunami may be coming within minutes. Move quickly to higher ground away from the coast.

Be careful to avoid downed power lines and stay away from buildings and bridges from which heavy objects might fall during an aftershock.

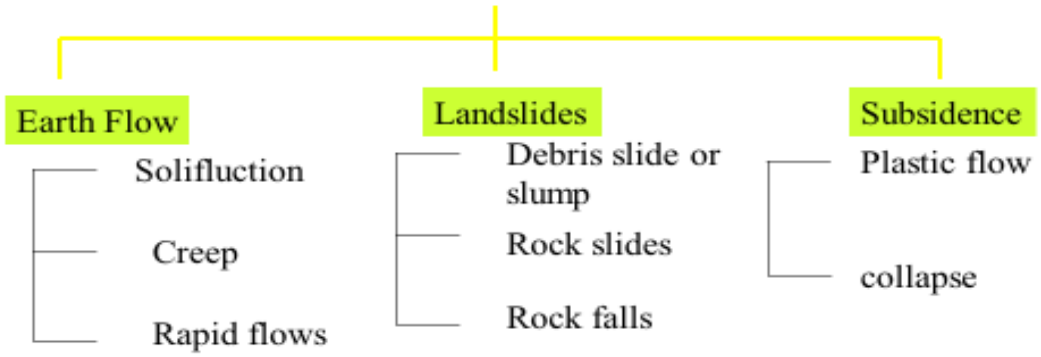
- **Avoid building or living in buildings within several hundred feet of the coastline.** These areas are more likely to experience damage from tsunamis, strong winds, or coastal storms.
- **Make a list of items to bring inside in the event of a tsunami.** A list will help you remember anything that can be swept away by tsunami waters.
- **Elevate coastal homes.** Most tsunami waves are less than 10 feet. Elevating your house will help reduce damage to your property from most tsunamis.
- **Follow flood preparedness precautions.** Tsunamis are large amounts of water that crash onto the coastline, creating floods.
- **Have an engineer check your home and advise about ways to make it more resistant to tsunami water.** There may be ways to divert waves away from your property. Improperly built walls could make your situation worse. Consult with a professional for advice.

6. Landslides

- Landslide: refers to the downward sliding of huge quantities of land mass which occur along steep slopes of hills or mountains and may be sudden or slow. If a mass of earth moves along a definite plane or surface the failure is termed as Landslide
- Large block known as a slump block moves during the landslide. The scar above a landslide is easily visible.
- They can occur along a slope where the internal resistance of the rocks are reduced or they loose their holding capacity. These are common after earthquakes or after removal of part of the slope due to construction, particularly for construction of roads.

Classification of Earth Movements

- All movement of land masses are referred as landslides, but differ in many respects, therefore all types of landslides are categorized as earth movements.
- These are classified as



- Solifuction is a downward movement of wet soil along the slopes under the influence of gravity.
- Soil Creep is extremely slow downward movement of dry surfacial matter.
- Movement of the soil occurs in regions which are subjected to freeze-thaw conditions. The freeze lifts the particles of soil and rocks and when there is a thaw, the particles are set back down, but not in the same place as before.
- Rapid flow is similar to the creep, but differ in terms of speed and depth. It is faster.
- Creep is involved upto shallow depth (app. 1-2 m), whereas the rapid flow is involved to greater depth (app. upto 5 m or more)

Debris slides & Rock slides

- During the movement, landslide can result into the
  A. Debris slides – where failure of unconsolidated material on a surface occurs;
  B. Rock slide or Rock Fall – where movement of large rock block rolls
- They are also common along the steep banks of rivers, lakes etc. Pore Water Pressure is the key to monitoring landslides. Shear strength (a resisting force) decreases and the weight (a driving force) increases.
- **Talus** – is accumulation formed by the coarser rock fragments resulted from the mechanical weathering along a slope under influence of gravity

C. **Subsidence** represents the downward movement of the surface

- It may occur due to plastic outflow of the underlying strata or due to the compaction of the underlying material
- (1) ***Subsidence due to Plastic outflow:*** It may occur when a plastic layer like

clay bed is squeezed outward due to overlying heavy load

- (2) ***Subsidence due to collapse:*** It occur due to extensive pull out of large volume of underground water or due to subsurface solution activity in limestone terrain.

General causes of landslides:

- ***Geological Weak material:*** weathered materials, jointed or fissured materials, contrast in permeability and contrast in stiffness
- ***Erosion:*** Wave erosion of slope toe, glacial erosion of slope toe, subterranean erosion
- ***Intense rainfall:*** Storms that produce intense rainfall for periods as short as several hours or have a more moderate intensity lasting several days have triggered abundant landslides.
- ***Human Excavation*** *of slope* and its toe, Loading of slope/toe, draw down in reservoir, mining, deforestation, irrigation, vibration/blast, Water leakage from services.
- ***Earthquake shaking*** has triggered landslides in many different topographic and geologic settings. Rock falls, soil slides and rockslides from steep slopes involving relatively thin or shallow dis-aggregated soils or rock, or both have been the most abundant types of landslides triggered by historical earthquakes.
- ***Volcanic eruption*** Deposition of loose volcanic ash on hillsides commonly is followed by accelerated erosion and frequent mud or debris flows triggered by intense rainfall.

Internal Causes:

- **Influence of slope-** Provides favourable condition for landslides; steeper slope are prone to slippage of land. It is known that most of the materials are stable upto certain angle- "Critical angle" or "angle of repose" – it varies from 30^0 for unconsolidated sediments to 90^0 for massive rocks and 60^0-90^0 for partially jointed rocks.
- **Ground water or associated water-** Main factor responsible for slippage. Suppose the hard or massive rocks are underlaid by softer rocks (shale or clay bed)
- When rain water percolates through some fractures or joints the clayey beds becomes very plastic and acts as slippery base, which enhance the chances of loose overburden to slip downward.
- Water is the most powerful solvent, which not only causes decomposition of minerals but also leaches out the soluble matter of the rock and reduces the strength.
- **Lithology-** rock which are rich in clay, mica, calcite, gypsum etc are prone to landslide because these minerals are prone to weathering.
- **Geological structures-** Occurrence of inclined bedding planes, joints, fault

or shear zone are the planes of weakness, which create conditions of instability.

- **Human Influence-** undercutting along the hill slopes for laying roads or rail tracks can result into instability.
- Deforestation in the uplands, result into more erosion during the rainy season.

External factors

- Most common is the vibration resulted due to earthquakes; blasting to explosives; volcanic eruption etc.
- Earthquakes often initiate mass failures on large scale
- eg. 1897 Assam quake produced gigantic landslide ever recorded in the region. The most common elements at risk are:

Elements at risk

- the settlements built on the steep slopes, built at the toe and
- those built at the mouth of the streams emerging from the mountain valley.
- All those buildings constructed without appropriate foundation for a given soil and in sloppy areas are also at risk.
- Roads, communication lines and buried utilities are vulnerable.

Indian landslides

- Landslide constitute a major natural hazard in our country account for considerable loss of life, damage to communication routes, human settlements, agricultural fields and forest lands.
- The Indian subcontinent, with diverse physiographic, seismotectonic and climatological conditions is subjected to varying degree of landslide hazards;
  - the Himalayas including North-eastern mountains ranges being the worst affected
  - a section of Western Ghats and the Vindhyas.
- Removal of vegetation and erosion have also triggered slides
- Torrential monsoon on the vegetation cover removed slopes was the main causative factors in the Peninsular India namely in Western Ghat and Nilgiris.
- Human intervention by way of slope modification has added to this effect.

Hazard zones

- The Landslide Hazard Zonation Map of India is used as a tool for regulating construction or development activities and means of managing or mitigating landslide disasters.
- The Landslide Map needs to be popularized among the architects, engineers and development planners and also to the public

Zone Significance of Landslides

The four point hazard scale of the Landslide Zones are – (1) Severe to Very High, (2) High, (3) Moderate to low, (4) Unlikely, was considered adequate. The zonal significance is given below:

Zone	Significance
Severe to Very High	The area is well known for the danger of landslides, and for the perennial threat to life and property. Restrictions on all new constructions and adoption of improved land use and management practices deserve to be encouraged. Investments on landslide remediation measures, on public education and on early warning systems are strongly indicated.
High	This is a zone in which landslides have occurred in the past and are already to be expected in the future. New constructions in this zone should be strictly regulated and construction should be done only after proper site investigation and implementation of appropriate remedial package. Before the new construction projects are cleared in this zone, environment impact assessment should be made mandatory.
Moderate to Low	Engineered and well-regulated new construction activities and well-planned agricultural practices could be permitted. All construction activities should however be based on technically evaluated and certified plans by established institutions and authorized consultants.
Unlikely	No visible sign of slope instability are seen in this zone in the present stage of knowledge. No blanket restriction needs to be imposed on various land use practices provided they confirm to the prevailing building regulations and bye-laws. Location specific limitations may become necessary for high-density urban areas.
	Snow covered areas

Main mitigation strategies

- ***Hazard mapping*** will locate areas prone to slope failures. This will permit to identify avoidance of areas for building settlements. These maps will serve as a tool for mitigation planning.

Land use **practices**:

- Areas covered by degraded natural vegetation in upper slopes are to be afforested with suitable species. Existing patches of natural vegetation (forest and natural grass land) in good condition, should be preserved
- Any developmental activity initiated in the area should be taken up only after a detailed study of the region and slope protection should be carried out if necessary.
- In construction of roads, irrigation canals etc. proper care is to be taken to avoid blockage of natural drainage
- Total avoidance of settlement in the risk zone should be made mandatory.
- Relocate settlements and infrastructure that fall in the possible path of the landslide
- No construction of buildings in areas beyond a certain degree of slope.
- ***Retaining Walls*** can be built to stop land from slipping (these walls are commonly seen along roads in hill stations). It's constructed to prevent smaller sized and secondary landslides that often occur along the toe portion of the larger landslides.

- ***Surface Drainage Control Works***. The surface drainage control works are implemented to control the movement of landslides accompanied by infiltration of rain water and spring flows.
- ***Engineered structures*** with strong foundations can withstand or take the ground movement forces. Underground installations (pipes, cables, etc.) should be made flexible to move in order to withstand forces caused by the landslides
- ***Increasing vegetation cover*** is the cheapest and most effective way of arresting landslides. This helps to bind the top layer of the soil with layers below, while preventing excessive run-off and soil erosion.
- ***Insurance*** will assist individuals whose homes are likely to be damaged by landslides or by any other natural hazards. For new constructions it should include standards for selection of the site as well as construction technique.
- The most damaging landslides are often related to human intervention such as construction of roads, housing and other infrastructure in vulnerable slopes and regions.

Community based mitigation

- Community based activities: are education and awareness generation among the communities, establishing community based monitoring, timely warning and evacuation system.
- Communities can play a vital role in identifying the areas where there is land instability. Compacting ground locally, slope stabilization and avoiding construction of houses in hazardous locations are something that the community has to agree and adhere to avoid damage from the possible landslides.
- This would also reduce the burden of shifting of settlements from hazardous slopes and rebuild in safe site as it is less practical to do in large scale.
- On 30 July 2014, a landslide occurred in the village of Malin in the Ambegaon taluka of the Pune district in Maharashtra, India.
- The landslide, which hit early in the morning while residents were asleep, was believed to have been caused by a burst of heavy rainfall, and killed at least 134 people.
- 50 men, 64 women and 20 children.
- In addition to those dead, more than 160 people, and possibly up to 200, were believed to have been buried in the landslide in 44 separate houses.
- The landslide was first noticed by a bus driver who drove by the area and saw that the village had been overrun with mud and earth.
- The landslides were caused by heavy rainfall that had begun the previous day, with the village receiving 10.8 cm (4 in) of rain on 29 July and the downpour continuing throughout the following day.
- The environmental destruction that resulted in the landslide is believed to have had more than one cause.

- Another cause cited as contributing to the landslide was deforestation in the area.
- One reason was changing agricultural practices – villagers had recently shifted from cultivation of rice and finger millet to wheat, which required levelling of steep areas, which contributed to instability of the hills.
- Also the construction of the nearby Dimbhe Dam ten years ago was considered as a possible reason.
- The instability of the hillsides was due to the construction activities, which are often done without careful analysis of environmental consequences.
- Stone quarrying, was also the reason for the instability of the hillside.
- Emergency services, including 378 personnel of the National Disaster Response Force, were mobilised to the area, and 8 victims had been rescued from the landslide prior to the evening of 30 July.
- Rains continued after the landslide making rescue efforts difficult.
- Rescue efforts had been hampered by poor road conditions and continuing rains.
- As of 31 July 22 people had been rescued alive from the landslide.
- On 4 August, the survivors of the landslide were ordered by the district administration to move out of Malin.
- Apart from the Security Forces, members of voluntary organisations like RSS & locals also helped in rescue operations. On 7 August, rescue operations officially drew to a close, with the final death toll estimate resting at 151.

7. <u>Avalanches</u>

- Large mass of rock debris or snow that moves rapidly down a mountain slope, sweeping and grinding everything in its path. Snow cover on a slope tends to slide down because of gravity.
- An avalanche begins when a mass of material overcomes frictional resistance of the sloping surface, often after its foundation is loosened by spring rains or is rapidly melted by warm, dry wind.
- Vibrations caused by loud noises, such as artillery, thunder, or blasting can create an avalanche. Avalanches usually occur in January, February, March. They can also occur in April when everything thaws.

<u>Causes</u>

- Conditions affecting stability include the gravitational force component of the snow and resisting forces, such as the frictional resistance of the slope or the anchoring effect of shrubs.
- In general, avalanches are caused when this balance is lost and when the forces exceed the resistance. They are rarely observed closely since they normally occur during a short time period of one or two minutes.
- **Major Causes** - can be classified into prime/fixed factors and

variable/exciting factors, such as weather conditions and the weight of the snow cover.

- Avalanches occur when these factors are combined. The types and scale of avalanches can differ depending on the combination of these various factors and their scale.

Item	Description	Factor
Prime factors	Topographic factors	• Inclination of slope • Shape of slope • Location (ridge line or toe of slope) • Orientation of slope
	Vegetation factors	• Vegetation cover and height of trees • Vegetation cover and its thickness
Exciting factor	Weather factors	• Depth of snow cover • Depth of snowfall • Wind velocity • Atmospheric and snow temperatures
	Other factors	• Increase in weight of snow cover because of snow dropping from cornices or snow covers • Vibrations such as earthquake or the sound of gunfire

Types of avalanches:

There are three different types of avalanches

1. A dry snow avalanche consists of powdery snow and air that can move faster than 100 mph.
2. A wet snow avalanche is a mass of partially melted snow that moves slower than a dry snow avalanche.
3. A slab avalanche is when a portion of snow breaks loose as a slab and splits into pieces as it slides.

Types and Description of Avalanches

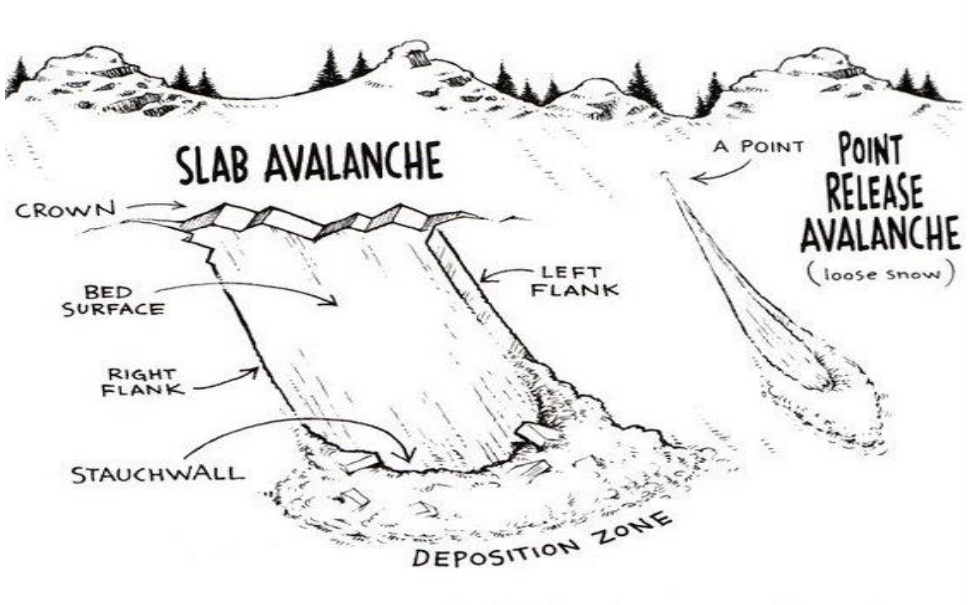
Dry, loose surface -layer snow avalanche	These often occur in low atmospheric temperature or during snowfalls. This type of avalanche is caused mainly by small masses of snow falling from snow cornices, tree branches or exposed rock. Dry snow moves down in loose layer.
Dry, slab surface -layer snow avalanche	These often occur when new snow with a depth of more than 10cm falls over existing snow cover during low atmospheric temperatures. Avalanches flow rapidly, taking the from of loose snow powder and often reach several kilometers down the foot of the mountain, causing serious disasters.
Dry, slab full-depth snow avalanche	Avalanche occurring in areas with low temperatures can have different mechanisms. In regions of relatively high temperatures, this type of avalanche occurs extensively when the weight of large quantity of snow falls quickly over existing snow deposits on slope at low temperatures. In cold regions, snow layers near the ground tend to become collapsible and can slide in a full depth if severe cold weather has continued for a long time. The dry new surface snow layers tend to slide in the form of snow powder and often reaches further down the foot of the mountain.
Wet, loose surface layer snow avalanche	These can be caused when a 20 to 30 cm layer of new snow layer starts to move, takes a wedge-shaped from and reduces in width. This avalanche flows smoothly as it advances.
Wet, slab surface layer snow avalanche	These can occur when temperature rises in fair weather after a snowfall when the slab snow surface layer contains water. Avalanches do not take the from of snow powder but move in a smooth flow.
Wet, slab full-depth snow avalanche	These can be caused when snow starts to melt in the early spring season and can also result if temperatures rise the winter season. It can occur either on a rainy day or on a warm day. These will not take the from of snow powder, and move in a smooth flow. This type of avalanche often causes serious disasters.

Loose-snow avalanches (sluffs)

- usually small and relatively harmless
- occur most frequently in newly fallen snow on steep slopes
- have little internal cohesion
- combination of light fluffy snow + gentle winds

Slab avalanches

- originate in all types of snow
- The most common and deadly type of avalanche in which a cohesive plate of snow shatters like a pane of glass and slides as a unit off the mountainside
- Happens when snow accumulates very rapidly. The sudden addition of weight can fracture a weak area below.
- Snow breaks away with enough internal cohesion to act as a single unit



Avalanche formation factors

- terrain
- weather
- snowpack
- humans

1. Terrain

Factors to be considered:

- slope angle
- slope size and shape
- vegetation and trees

- Slope angle refers to the steepest part of the slope and the real avalanche danger zone. A critical angle of 30-45^{o} is considered to be the initiator of an avalanche.
- Slope size and shape refers to the convexities and concavities- the zone of tension and zone of compression under the influence of gravity.
- Vegetation and trees can anchor snow, but depends on amount of trees, the ground cover affects, effective snow depth and heat transfer snow metamorphism in basal layers.
- Vegetation may change because of the implications of timber cutting, forest fires, removal of ground cover etc which might also trigger avalanches

2. **Weather patterns** such as precipitation (snow or rain), wind and temperature affect the snow stability.

- changes in temperature can affect snow stability
  - change during storms
  - rapid warming
  - metamorphism effects

3. **Snowpack**

- "Can the snowpack avalanche?"
- **Snowpack** forms from layers of snow that accumulate in geographic regions and high altitudes where the climate includes cold weather for extended periods during the year.
- Assessing the formation and stability of snowpacks is important in the study and prediction of avalanches.
- Scientists study the physical properties of snow under different conditions and their evolution, and more specifically snow metamorphism

4. **Human factors**

A person's weight can trigger an avalanche, too. In fact, some 90 percent of avalanche accidents involving people were triggered by the victim or someone in the victim's party.

Other human factors such as decision making, route finding/travel habits, emotions and logic, preparedness and education also plays a key role.

Where do avalanches occur???

- Avalanches can occur anywhere in the world.
- They occur where ever there is a high snow covered mountain.
- Avalanches can also occur near plate boundaries. Usually at convergent plate boundaries.

Elements at risk

- Avalanches don't do a lot of damage to cities or towns because they are up in the high mountains.
- Avalanches burry mountain side homes and destroy forests.
- They also take down radio towers and lodges that are in its path.
- Avalanches also take away people's lives, especially skiers who are taking a trip down the mountain.

Avalanches Prone Areas in India

- The Himalayas are well known for the occurrence of snow avalanches particularly Western Himalayas in the snowy regions of Jammu and Kashmir, Himachal Pradesh and Western Uttar Pradesh.
- Jammu and Kashmir - Higher reaches of Kashmir and Gurez valleys, Kargil and Ladakh and some of the major roads
- Himachal Pradesh - Chamba, Kullu- Spiti and Kinnaur vulnerable areas
- West Uttar Pradesh - Parts of Tehri Garhwal and Chamoli districts are vulnerable areas.

If caught in an avalanche

- Yell and let go of ski poles and get out of your pack to make yourself lighter.
- Use "swimming" motions, thrusting upward to try to stay near the surface of the snow.

- Above all, do not panic. Keeping your breathing steady will help preserve your air space and extend your survival chances. If you remain calm, your body will be better able to conserve energy.
- When the avalanche comes to a stop try and dig your way up to the surface if you know you are close.
- If you are in over your head (not near the surface), try to maintain an air pocket in front of your face using your hands and arms, punching into the snow.
- If you are in an area that is highly at risk for avalanches be sure not to ski or use any snowmobiles on the mountain.
- Try not to use any explosives around an avalanche zone.
- If there was a heavy snow fall the night before make sure not to go on the mountain because you might trigger an avalanche.
- Don't ever go alone on a mountain that has been known to have avalanches.

Mitigation measures

- To prevent avalanches build up snow fences to prevent buildup of snow in the starting-zones.
- Also defecting walls are built up to divert avalanche flows away from buildings and even entire towns.
- Sheds are also build across roadways that pass through persistent avalanche paths and they can help to protect motorists from avalanches.
- Slopes with trees help to prevent avalanches.
- They use explosives to set off small avalanches in areas that are of potential danger. This is to reduce the size of future avalanches in the risk area.
- Avalanches don't happen over a period of time like other natural hazards do.
- They happen because of vibrations and heavy snow fall so you can't really say when they are going to happen until they actually do.
- Research is going on to find out about the mechanisms that govern the build-up of snow - wind and precipitation - instability within the snow cover, and the flow of avalanches.
- The main objective of this research is to improve zoning and make defences more effective and more reliable.
- Avalanche dogs are used after an avalanche has occurred. They sniff through the snow to try and find any people that might be buried underneath.

UNIT III

Human induced hazards: Risks and control measures in a chemical industry, Causes, impacts and mitigation measures for chemical accidents, chemical disaster management, current status and perspectives; Case studies related to various chemical industrial hazards eg: Bhopal gas tragedy; Management of chemical terrorism disasters and biological disasters; Radiological Emergencies and case studies; Case studies related to major power break downs, fire accidents and traffic accidents .

1. Chemical disasters

- The growth of chemical industries has led to an increase in the risk of occurrence of incidents associated with hazardous chemicals (HAZCHEM).
- Chemical accidents may be categorised as a major accident or a disaster depending upon the number of casualties, injuries, damage to the property or the environment.
- Common causes for chemical accidents are deficiencies in safety management systems, human errors, natural calamities or deliberate activities.
- Chemical accidents result irreversible pain, suffering and death.

A chemical industry that incorporates the best principal of safety can prevent such accidents.

Sources of Chemical Disasters

Chemical accidents may originate in:

- i) Manufacturing and formulation installations including during commissioning and process operations; maintenance and disposal.
- ii) Material handling and storage in manufacturing facilities, and isolated storages; warehouses and godowns including tank farms in ports, docks and fuel depots.
- iii) Transportation (road, rail, air, water, and pipelines).

Causative Factors

- i) Fire.
- ii) Explosion.
- iii) Toxic release.
- iv) Poisoning.
- v) Combinations of the above.

- Chemical disasters may occur due to process deviations concerning the chemistry of the process, pressure, temperature and other identified parameters with regard to the state of the substance i.e., solid, liquid or gas,
- proximity to other toxic substances and the probability of a runaway reaction due to the incidental mixing of two or more HAZCHEMs with dissimilar properties.

- In addition, it may be due to hardware failure, resulting in large-scale spills of toxic substances (in any form) due to loss of containment, or an explosion.
- sparks, shocks or frictional forces on the chemicals during transportation.
- The effects can be further aggravated by the micro-meteorology of the area, wind speed and direction, rate of precipitation, toxicity/quantity of chemical released, population in the reach of release and other industrial activities being performed in closer vicinity.

Initiators of Chemical Accidents

A number of factors including human errors could spark off chemical accidents with the potential to become chemical disasters. These are:

I Process and Safety System Failures:

- i) Technical errors: design defects, fatigue, metal failure, corrosion etc.
- ii) Human errors: neglecting safety instructions, deviating from specified procedures etc.
- iii) Lack of information: absence of emergency warning procedures, non disclosure of line of treatment etc.
- iv) Organisational errors: poor emergency planning and coordination, poor communication with public, noncompliance with mock drills/exercises etc., which are required for ensuring a state of quick response and preparedness.

II Natural Calamities:

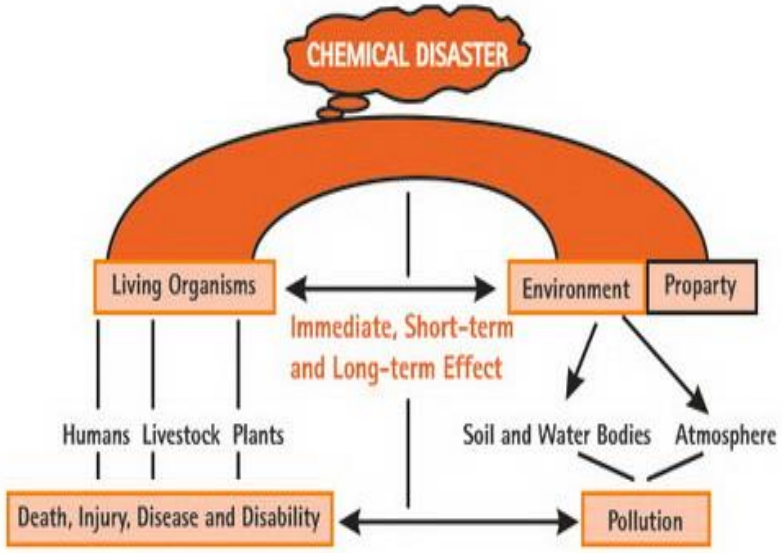
- The Indian subcontinent is highly prone to natural disasters, which can also trigger chemical disasters.

Examples:

- Damage to phosphoric acid sludge containment during the Orissa super cyclone in 1999 and the release of acrylonitrile at Kandla Port, during earthquake in 2001.

III Terrorist Attacks/Sabotage:

- Vulnerability to chemical disasters is further compounded by likely terrorist and warfare activities, which include sabotage and attack on HAZCHEM installations and transportation vehicles.



Indian Scenario

- The Indian Chemical Industry contributes to 6.7% of the GDP.
- Indian Fertilizer Industry is the fourth largest in the world.
- Largest manufacturer of Pesticides in Asia second to Japan.
- Indian Pharmaceutical industry is the largest in the developing world.
- There are around 1790 Major Accident Hazard units in the country, handling large number of chemicals as raw materials, in processes, products and wastes with flammable, explosive, corrosive, toxic and noxious properties.
- Handling of large quantities of hazardous chemicals in installations, isolated storages and during transportation, poses grave risk of sudden release of copious quantities of toxicants. This may adversely impact both the communities in and around the area and the environment.

Genesis of NDM Guidelines for Chemical Disasters

As per the DM Act, 2005, the NDMA prepared national Guidelines, based on which the nodal ministry prepared a detailed Action Plan in consultation with states and other stakeholders for the better and effective management of chemical disasters.

A meeting on CDM was convened by the NDMA on 17 February 2006 with various ministries of the Government of India along with a large number of professionals and experts from the field of CDM.

- During the workshop, the present status of CDM in India was discussed and salient gaps were identified.
- The workshop also identified priority areas for prevention, mitigation and preparedness of chemical disasters and provided an outline of comprehensive guidelines to assist in the preparation of plans by ministry/states.

- It was decided to articulate the CDM guidelines through a document called the National Disaster Management Guidelines—Chemical Disasters.

- The Government of India has reinforced the legal framework on chemical safety and management of chemical accidents by enacting
- The Factories Act, 1948
- The Explosives Act, 1884
- The Insecticide Act, 1968
- The Petroleum Act, 1934
- The Environmental Protection Act
- Factories Act and Environmental Protection Act, Public Liability Act, and rules there under prescribe the planning, preparedness and response in chemical emergencies, whereas Disaster Management Act (2005) provided a holistic framework for multi-hazard disaster management at various levels.
- Proper decisions starting from site selection, public participation in clearance, industrial layout planning, disaster mitigation measures, on-site and off-site emergency coordination planning - play key roles in furthering the objectives of a comprehensive framework of disaster management at local and district level.
- Ministry of Environment & Forests has been identified as a nodal agency for management of chemical disasters in the country.
- Ministry of Labour & Employment through its organization at state level on industrial safety and/or factories and boilers provide a framework for implementation and monitoring at state, district and sub-district levels.
- A number of chemical specific codes of practises published by the Bureau of Indian Standards (BIS), the Oil Industry Safety Directorate (OISD) and guidelines brought out for chemical accident management by the MoEF are also issued.
- Organisations/agencies like the DAE and Centre for Fire, Explosive and Environment Safety (CFEES) are responsible for preparing Off-Site emergency plans in the DAE and MOD respectively.
- The CFEES is an authority under the MSIHC Rules, 1989 for enforcement of directions and procedures in respect of laboratories, industrial establishments and isolated storages dealing with HAZCHEMs in the MOD.
- The DAE is responsible for nuclear installations.
- Research institutes like the IICT, Hyderabad; ITRC, Lucknow; NEERI, Nagpur; NCL, Pune and NIOH, Ahmedabad, are working in the field of occupational hazard, safety and in aspects related to CDM.
- DRDO is working on the field detection kits, personal protection equipment and measures for prophylaxis and therapy.
- Autonomous bodies, professional institutes, Private Voluntary Organizations (PVOs) and NGOs play an important role in training and community

awareness and also can contribute significantly in response, rehabilitation and reconstruction efforts.

- The MoEF has set up a Crisis Control Room (CCR) as part of the CAS, for the rapid exchange of information and for coordination of activities during an emergency.
- The MoEF is preparing a web-based accident information system for use of all stakeholders concerned, which will have better monitoring and management of chemical disasters.
- A 'red book' containing duties to be performed by authorities and agencies during an emergency is published periodically and circulated. It contains names, addresses and telephone numbers of key functionaries of state governments, chief inspectorate of factories, SPCBs, PCC, experts/institutions, etc.
- A brochure entitled, 'DOs and DON'Ts during a Chemical Accident', to educate and enable the community for self-protection has been published. Industries have also undertaken awareness programmes for communities residing in the vicinity of industrial units.

Environmental Guidelines

The following environmental guidelines are recommended for sitting of industries to ensure optimum use of natural and manmade resources in sustainable manner with

- Minimal depletion
- Degradation
- Destruction of the environment
- The following distances from industrial sites should be taken into account.
- Ecological and/ or otherwise sensitive areas-At least 25 km away, depend on the geo-climatic conditions. The requisite distance shall have to be increased by appropriate agency.

- Coastal Areas- At least ½ km from high tide line floodplain of the Riverine Systems.
- At least ½ km from floodplains or modified floodplains, affected by dams in the upstream or by flood control systems.
- Transport / Communication system- At least ½ km from the high way lines and railway station
- Major settlements- Distance from settlements is difficult to maintain because of urban sprawl
- At the time of sitting of the industry if any major settlements are noted within 50 km the spatial direction of growth of the settlement must be assessed
- The industry shall be sited at least 25 km from the projected growth boundary of the settlement

Chemical agent: Any chemical element, compound or a mixture of them, as it occurs in the natural state or as produced, used or released by any work activity or come about as waste or produced unintentionally.

Hazardous chemical agent: Any substance that has one or more of characteristics that are toxic for reproduction and dangerous for the environment like being explosive, oxidizing, easily flammable, flammable, toxic, very toxic, hazardous, corrosive, irritating, allergic, carcinogen, mutagen.

Hazards associated with Chemicals

Chemical agents can cause harm either directly

- Harm can become apparent rapidly or even immediately after contact (Acute Effect)
- Or appear in the long term due to repeated exposure over time (Chronic Effect)
- If the harm is apparent at the point of the contact of chemical and the body (Local Effect)
- Or if it may appear following a process of absorption and distribution through the body (Systemic Effect)

(Or) by producing some form of energy (such as fire or explosion):

- The harm is caused by the energy produced by the fire or explosion of chemical agents.
- Explosions occur when a sudden oxidation or decomposition reaction occurs producing a temperature and pressure rise or both simultaneously.

Chemical agents present in workplace may pose risks to health and safety on account of:

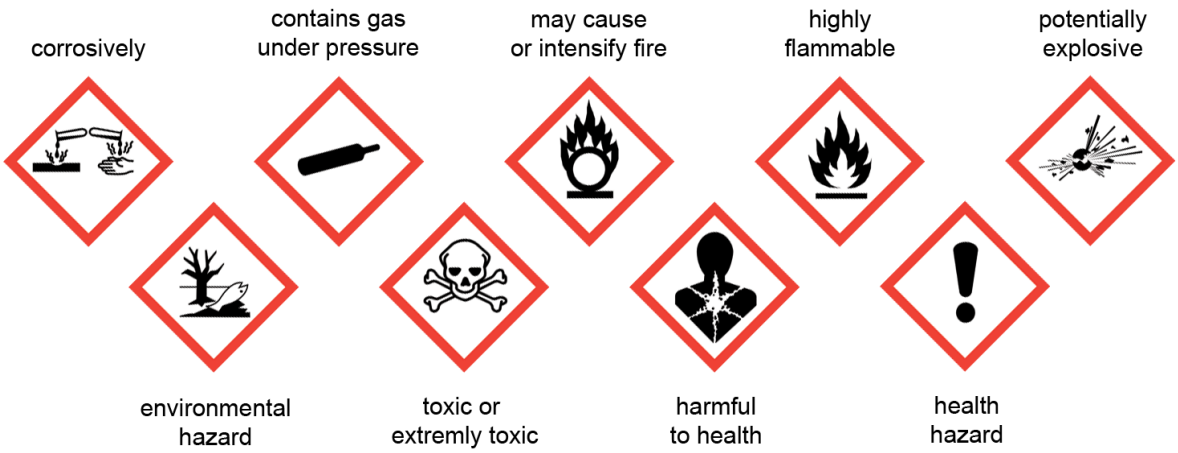
1. Their hazardous properties (physico-chemical or toxicological) (e.g. explosive or sensitiser)
2. The temperature or pressure at which they occur in the workplace (e.g. water vapor at 150°C)
3. Their capacity to displace the atmospheric oxygen from the workplace (e.g. pressurized inert gas)
4. The manner in which they are present in the workplace (e.g. inert solid in the form of a breathable powder)

Risks of chemicals to be assessed

1. The risk of fire and/or explosion
2. Risk generated due to the hazardous chemical reactions which may affect the health and safety of workers
3. Risk due to inhalation
4. Risk due to absorption through the skin
5. Risk due to contact with skin or eyes
6. Risk due to ingestion

- In order to determine the risks of a chemical agent; the hazardous properties of these chemicals and the way in which they are present and are used must be known.
- To assess the risks first be informed about the hazardous properties of chemicals.

1. Labeling
2. Safety Data Sheets
3. Occupational Exposure Limit Values and Biological Limit Values



To Eliminate or Reduce the Risks

1. Design and organisation of systems at the workplace.
2. Provision of suitable equipment for work with chemical agents and maintenance procedures which ensure the health and safety of workers at work.
3. Reducing to a minimum the number of workers exposed or likely to be exposed.
4. Reducing to a minimum the duration and intensity of exposure.
5. Appropriate hygiene mesures.
6. Reducing the quantity of chemical agents present at the workplace to the minimum required for the type of work concerned.
7. Suitable working procedures including arrangements for the
8. Safe handling, storage and transport within the workplace of hazardous chemical agents and waste containing such chemical agents.

Safe Storage of Chemicals

In chemical industries, storage and use of bulk quantities of highly flammable and toxic substances are often inevitable, but always poses a threat to the employees inside the industry, as well as to the neighbouring community and environment.

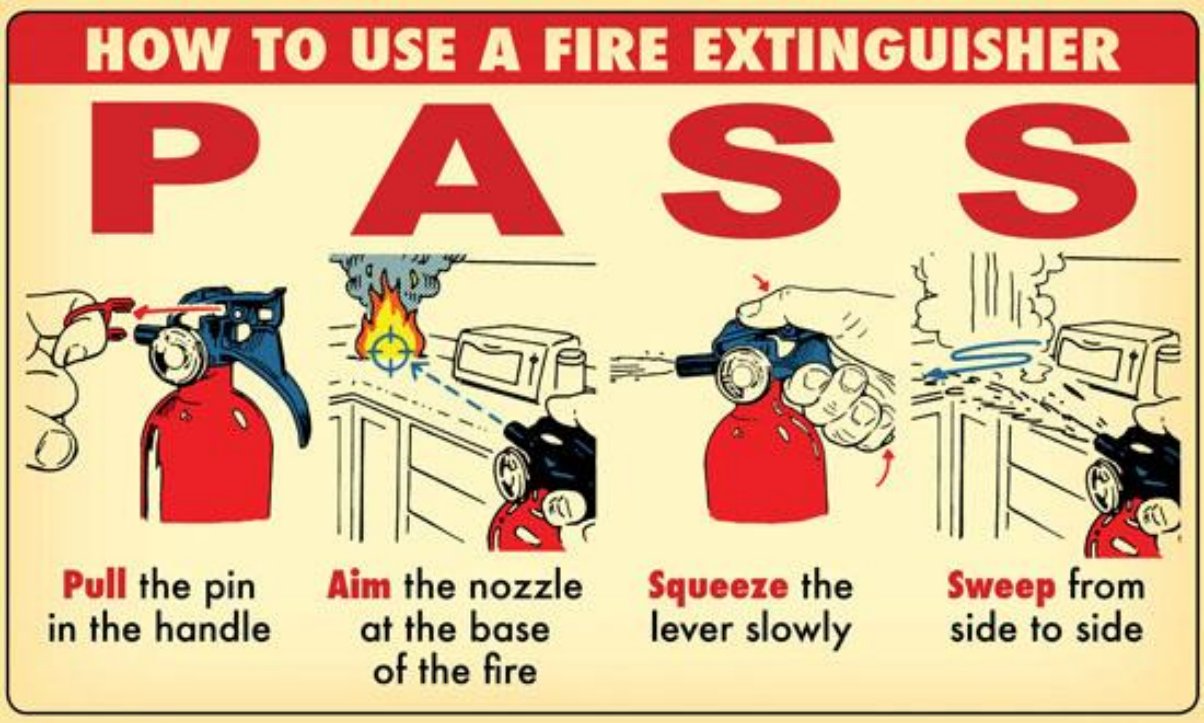
- ❑ In terms of prevention, the main measure is to maintain the hazardous chemical stocks at the lowest possible level.
- ❑ Then maintain safe storage area away form process area or other hazardous areas.
- ❑ Avoid the combined storage of incompatible or highly reactive chemicals
- ❑ Provide secure containers (sufficient physical resistance, automatic closure, appropriate for the type and quantity of chemical stored etc.)
- ❑ All packages in storage shall be labeled to allow unmistakable identification of the contents.
- ❑ Evacuation routes and emergency exits to be provided
- ❑ Precise work instructions for storage operations
- ❑ Written action procedures in the event of incidents (leaks, spillage, emissions)

To avoid explosion

To avoid the possibility of an explosion or the emission of toxic flammable or corrosive gases:

- Store two incompatible chemicals at least 3m apart.
- Where the goods could react violently, store them at least 5m apart.

Consider storing some chemicals especially unstable chemicals in separate fire rated enclosures or separate buildings with appropriate fire suppression equipment.



The Bhopal Gas Disaster, India, 1984

- The Union Carbide plant had once been port of an ambitious Indian plan to achieve self-agricultural production by increasing the national production of pesticides.
- The night of 2-3rd December 1984 in Bhopal, India, at 23:00, while most of Bhopal's 9,00,000 inhabitants were sleeping an operator of the Carbide plant noticed a small leak as well as elevated pressure inside storage tank 610, which contained methyl isocyanate (MIC), a highly reactive chemical used as a intermediate in the production of the insecticide Sevin.
- The leak had been created by a strong exothermic reaction resulting from mixing of one tone of water normally used for cleaning internal pipes with 40 tonnes of MIC contained in the tank.
- Because coolant for the refrigeration unit had been previously for use in another part of the plant, tank 610 could not be cooled quickly. Therefore, pressure and heat continued to build inside the tank and the tank continued to leak.
- Both the vent gas scrubber and the gas flare system, two safety devices designed to neutralize potential toxic discharges from the tank before they escaped into the atmosphere, had been turned off several weeks before.
- At around 1:00, a loud rumbling echoed around the plant as the safety valve of the tank gave way. Nearly 40 tonnes of MIC gas was released into the

morning air of Bhopal. It did not take long for the plume, carried by the changing winds, to spread over a large area.

- At least 3800 people died immediately, killed in their sleep. Local hospitals were soon overwhelmed with the thousands of injured people.
- The crisis was further deepened by a lack of knowledge of exactly which gas was involved and hence what the appropriate course of treatment should be.
- Estimates of the number of people killed in the first few days by the plume from the Union Carbide plant are as high as 10 000, with 15 000 to 20 000 premature deaths reportedly occurring in the subsequent two decades.
- The Indian government reported that more than half a million people were exposed to the gas. The greatest impact was on the densely populated poor neighbourhoods immediately surrounding the plant.
- The Bhopal incident was the result of a combination of legal, technological, organizational and human errors. The severe health effects of the chemical reaction that ensued were certainly aggravated by the failure of the various safety measures and the lack of community awareness and emergency preparedness.
- Economic pressure faced by industry, communities and governments can be a contributing factor that influences the likelihood and security of a chemical incident.
- The Bhopal disaster brought into sharp focus the unprecedented potential of hazardous chemical release in terms of loss of life, health, injury and evacuation.
- It created a compelling evidence to approach disaster management and chemical safety holistically.
- The disaster brought in its wake, an era of restructuring and inducting new hazardous chemical control systems and procedures all over the world

Post Bhopal Gas Disaster

- Factories Act was amended to assign responsibility for workplace safety to the Occupier.
- Environment Protection Act was introduced in 1986.
- The Manufacture, Storage & Import of Hazardous Chemicals Rules, 1989.
- The Chemical Accidents, Emergency Planning, Preparedness and Response, 1996 introduced.

Industrial Hazards

Industrial hazards consist of four principle hazards. The hazards encountered are fire, explosion, toxic release and environmental damage.

- **Fire:** This is the most frequent of the hazards however the consequences are generally less. The effect of fire on people usually takes the form of skin burns and is usually dependant on the exposure time and the intensity of the heat. Fire can also produce toxic fumes like Acrolein, Carbon monoxide and Cyanides. Physical structures can be damaged either by the intensity of the heat or combustion. It may also have an effect on essential services like power and instrumentation which can cause an escalation of the incident.

- **Explosion:** Explosions are usually heard from far away as a 'bang'. This is the result of a shock wave. This overpressure can kill people but usually the indirect effects of collapsing buildings, flying glass and debris causes far more loss of life and severe injuries. There are different types of explosions which include gas explosions and dust explosions. Gas explosions occur when a flammable gas mixes with air and is exposed to an ignition source. Dust explosions occur when flammable solids, especially metals, in the form of fine powders are intensively mixed with air and ignited.

- **Toxic/Chemical release:** Sudden releases of toxic vapours have the potential to cause death and severe injuries several miles from the release point. They are carried by water and air. Their release into public sewage systems, rivers, canals and other water courses, either directly or through contaminated water used in firefighting can result in serious threat to public. The number of casualties depends on the weather conditions, population density in the path of the cloud and the effectiveness of the emergency arrangements.

- **Environmental Damage:** As well as having the potential for causing injury, loss of life and damage to property, the hazards of fire, explosion and toxic releases may pose a severe threat to the environment. Release of other substances, not directly toxic to humans can cause major pollution problems. It is becoming increasingly recognized that damage to natural resources such as plant and animal life can have serious long term consequences. E.g. destruction of trees is increasing the effect of global warming and extinction of animals are severely disrupting food webs and causing an increase in pests.

- ❑ Improper location of Communities
- ❑ Poor developmental planning
- ❑ Lack of knowledge
- ❑ Lack of mitigation measures
- ❑ Lack of evacuation expertise
- ❑ Transportation risks

How to reduce risks

- ❑ Design and Pre-modification review: this involves proper layout, facilities and material selection. Research should be done try to substitute extremely toxic chemicals with safer ones.
- ❑ Chemical Risk Assessment: Chemicals are assessed based on compatibility, flammability, toxicity, explosion hazards and storage.
- ❑ Process Safety Management: HAZOP studies, reliability assessment of process equipment, incorporating safety trips and interlocks, scrubbing system, etc. should be done before effecting major process changes.
- ❑ Safety Audits: Periodical assessment of safety procedures and practices, performance of safety systems and gadgets along with follow up measures should be carried out.
- ❑ Emergency Planning: A comprehensive risk analysis indicating the impact of consequences and specific written down and practiced emergency procedures along with suitable facilities should be done.

- Proper storage of hazardous Materials
- Training: Proper training of employees and protective services should be done.
- Special times and escorts for dangerous vehicles should be provided
- Public Cooperation on the road is expected
- Public awareness: Everyone should be aware of potential disasters and informed of protective and safety measures.

Hazard and Operability Study (HAZOP)

Operability is the ability to keep an equipment, a system or a whole industrial installation in a safe and reliable functioning condition, according to pre-defined operational requirements.

- A HAZOP is a systematic approach for investigating each element of a process to identify all of the ways in which parameters can deviate from the intended design conditions and create hazards or operability problems.

- A Hazop Study typically involves using the plant model, as a guide for examining every section and component of a process.
- The hazop team includes people with a variety of expertise such as operations, maintenance, instrumentation, engineering/process design, and other specialists as needed to view potentially hazardous situations that could arise in each section of pipe, each valve, and each vessel in the system.
- In a Hazop Study, the hazop team works through the P&IDs examining the impact of potential changes to parameters such as flow, temperature, pressure and time.
- Using their experience they determine the effects of deviations from design conditions. All potential causes of failure are identified.
- Existing safeguards and protection systems are identified and their ability to handle the deviations are evaluated.

Typical actions a Hazop Study might recommend include:

- A review of existing protection system designs by a specialist
- Adding or modifying alarms that warn of deviations
- Adding or modifying relief systems
- Adding or modifying ventilation systems
- Increasing sampling and testing frequency
- Implementation of additional engineering controls

The Role of Labeling in Hazop

- Process system components such as mixers, piping, valves, sample points, instruments and vessels must be identified and labeled in accordance with the P&IDs. Opening a wrong valve, or starting to cut a wrong pipe, have often been the causes of serious accidents.

Major Power Breakdowns

- A power blackout is a short- or long-term loss of the electric power to an area.
- Two severe power blackouts affected northern and eastern India on 30 and 31 July 2012. The 31 July 2012 India blackout was the largest power outage in history.
- The outage affected over 620 million people, about half of India's population, spread across 22 states in Northern, Eastern, and Northeast India.
- An estimated 32 gigawatts of generating capacity was taken offline in the outage.
- Electric service was restored in the affected locations between 31 July and 1 August 2012.
- Over 600 million people and all community power-dependent systems were affected.
- The worst blackout in India's history reinforced concerns that the nation's inefficient power sector could undermine its long-term economic ambitions to become a "SUPERPOWER".
- The scale of the blackouts caused India acute embarrassment on the international stage.

Causes

- ❑ India's antiquated power systems
- ❑ An increase in peak demand by an unexpected need to pump water from wells for agricultural uses due to much less rain during the monsoon season
- ❑ Low rainfall has also restricted the amount of hydroelectric power delivered by dams,
- ❑ Some states have drawn too much power from the grid, in defiance of regulations.
- ❑ Central government was supposed to warn states if they were drawing excessive power from the system, but NO warnings were issued.

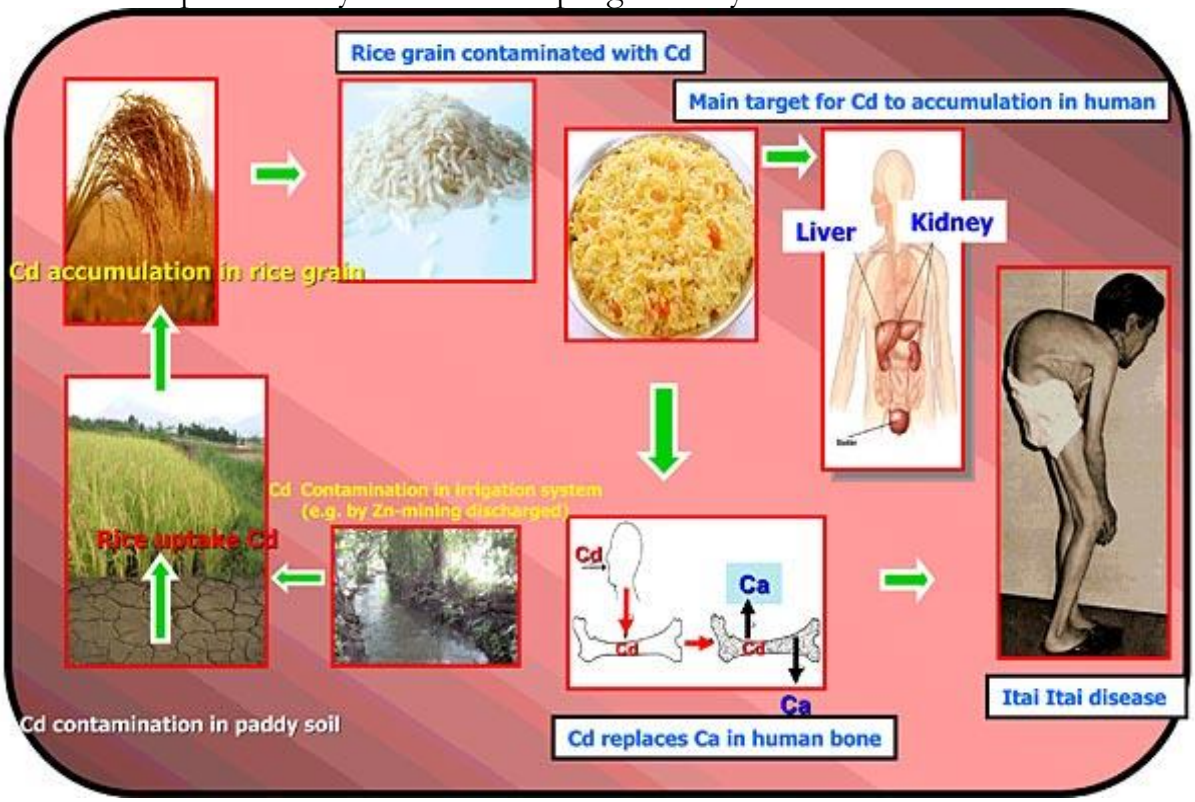
Effects

- All power-dependent community functions (e.g., government, business enterprise, hospitals, schools, in these states, were shut down.
- Some major city hospitals and office buildings had to fire up diesel generators.
- Trains and subways brought to a halt.
- Two hundred miners were stranded in three deep coal shafts in the state of West Bengal when their electric elevators stopped working.
- Wheat-belts in Punjab and Uttar Pradesh in the Ganges Plains, needing electricity to pump water from wells, were hit hard

Environmental Disasters

Itai-Itai Disease

- The strange disease that appeared in Jinzu River around 1912 was called as Itai-Itai disease, was because of the release of cadmium from Kamioka Mine.
- The cadmium came from upstream into the Jinzu River by commercial activities of the Kamioka Mining Co., Ltd. at Kamioka Mines."
- Women were mostly afflicted with pain across their entire body and more severe cases suffered broken bones.
- It was chronic cadmium poisoning caused by heavy metals such as zinc and lead contained in water of the Jinzu River."
- It first impairs kidney function and progressively causes osteomalacia.



Minamata Disease

- The events took place in Minamata, 1956, which is a city located on the west coast of the southernmost island of Japan.
- Minamata was a poor fishing community whose residents relied almost exclusively on fish and shellfish from the surrounding bay as a source of protein.
- Chisso was a local company that produced acetaldehyde, which is a chemical used to produce plastics.

- Dead fish began to float in Minamata Bay. Cats began exhibiting peculiar behavior. They started walking so strangely that the people said the cats were "dancing".
- Soon after, some people began to act strangely. Fishermen and their families were the earliest and most severely afflicted. They would stumble while walking, not be able to write.
- Some had trouble hearing and swallowing, and sometimes trembled uncontrollably. These symptoms were the start of a nervous condition caused by ingesting Mercury.
- Mercury contaminated waste water from Chisso's production of plastics spilled into the bay was the main reason.
- Mercury entered the food chain and concentrated through bio-magnification.
- Mercury concentrates itself in the brain and spinal cord. Early effects of Mercury poisoning include loss of feeling in the hands and feet and loss of peripheral vision. Patients in advanced stages of the condition showed considerable shrinking of the brain.
- Symptoms include uncoordinated walking, tremors, and violent convulsions. The effects of Mercury poisoning can even lead to death.
- The Mercury poisoning in Minamata killed 3,000 people and made over 10,000 people sick.
- The outcome was tragic. A whole town was poisoned. This shows how elements, such as Mercury, can concentrate in the food chain and it also shows the importance of clean water.
- The activities of people can have dramatic and deadly effects on the environment.

The Great London Smog 1952

- A thick fog engulfed London from December 5 to December 9, 1952,
- it mixed with black smoke emitted from homes and factories to create a deadly smog.
- When a severe cold spell hit London in December 1952, they burned more coal to heat up their homes. Then on December 5, 1952, a layer of dense fog engulfed the city and stayed for five days.
- Since the smoke from the coal burning in homes and factory emissions, had been prevented from escaping into the atmosphere by an inversion, the fog and smoke combined into a rolling, thick layer of smog.
- Visibility across London became extremely poor. Transportation across the city came to a standstill.
- In the five days the smog had covered London, over 4,000 people had died. In the following weeks, approximately 8,000 more died from exposure to what has become known as the Great Smog of 1952. Most of those killed by the Great Smog were people who had pre-existing respiratory problems and the elderly.

- The death toll of the Great Smog of 1952 was shocking. This smog killed approximately 12,000 people and shocked the world into starting the environmental movement.

Deep water horizon oil spill

- The *Deepwater Horizon* oil spill (the BP oil spill, the BP oil disaster, the Gulf of Mexico oil spill, and the Macondo blowout) began on 20 April 2010 in the Gulf of Mexico on the BP-owned Transocean-operated Macondo Prospect.
- The explosion killed 11 workers and injured 16 others. The explosion caused the *Deepwater Horizon* to burn and sink, resulting in a massive offshore oil spill in the Gulf of Mexico, considered the largest accidental marine oil spill in the world, and the largest environmental disaster in U.S. history.
- The fire aboard the *Deepwater Horizon* reportedly started at 9:56 p.m. on April 20, 2010. At the time, there were 126 crew on board: seven employees of BP, 79 of Transocean, as well as employees of various other companies involved in the operation of the rig.
- Abnormal pressure had accumulated inside the marine riser and as it came up it "expanded rapidly and ignited".
- A bubble of methane gas escaped from the well and shot up the drill column, expanding quickly as it burst through several seals and barriers before exploding.
- Survivors described the incident as a sudden explosion which gave them less than five minutes to escape as the alarm went off. Following the explosion and sinking of the *Deepwater Horizon* oil rig, a sea-floor oil gusher flowed for 87 days, until it was capped on 15 July 2010.
- The US Government estimated the total discharge at 4.9 million barrels. After several failed efforts to contain the flow, the well was declared sealed on 19 September 2010.

Environmental Impact

- Numerous investigations explored the causes of the explosion. The U.S. government's September 2011 report pointed to defective cement on the well, faulting BP, and also rig operator Transocean.
- Due to the months-long spill, extensive damage to marine and wildlife habitats and fishing and tourism industries was reported.
- The spill area hosts 8,332 species, including fish, birds, molluscs, crustaceans, sea turtles and other marine mammals.
- Between May and June 2010, the spill waters contained 40 times more PAHs than before the spill. PAHs are often linked to oil spills and include carcinogens and chemicals that pose various health risks to humans and marine life.

- In 2013, researchers found that oil on the bottom of the seafloor did not seem to be degrading, and observed a phenomenon called a "dirty blizzard": oil in the water column began clumping around suspended sediments, and falling to the ocean floor in an "underwater rain of oily particles." The result could have long-term effects because oil could remain in the food chain for generations.
- In Louisiana, 4.6 million pounds of oily material was removed from the beaches in 2013, over double the amount collected in 2012.
- In 2013 it was reported that dolphins and other marine life continued to die in record numbers with infant dolphins dying at six times the normal rate.
- One study released in 2014 reported that tuna and amberjack that were exposed to oil from the spill developed deformities of the heart and other organs that would be expected to be fatal.
- A massive response ensued to protect beaches, wetlands and estuaries from the spreading oil utilizing skimmer ships, floating booms, controlled burns and 1.84 million US gallons (7,000 m3) of oil dispersant.

Traffic Accidents

- Road safety is a major public health concern.
- Indian road network is second longest in the world covering more than 3 million Kilometers.
- 85% of passenger loads and 70% of freight load is carried by road.
- Types of vehicles plying on Indian roads along with their wrong usage according to their capacity is a matter of great concern for road safety.
- These vehicles create traffic chaos and are a cause of road crashes.
- India has only 1 % of world vehicle population, but accounts for 6 % of the accidents and 10 % fatalities due to road traffic injuries.
- Total economic loss to society on account of road accidents is estimated to be approx. Rs. 55000 crores per annum.
- In India 11 % of deaths due to non-communicable diseases are due to injuries and 78 % of these injury deaths are due to road traffic crashes. Hence road safety becomes important responsibility of the governments.

Factors affecting Road Traffic Crashes

- Types of roads and road users.
- Colliding vehicles.
- Environment and road related factors like road geometry, design, visibility, diversions etc.
- Vehicle related causing traffic mix.
- Adherence / enforcement of road safety regulations.
- Unsafe driving behavior.

- Traffic congestion caused by increased use of private mode of transport and less practice of vehicle pooling.
- Highway capacity shortages
- Lack of valid and fake driving licenses
- Nature of traffic management.

Fire Hazards

- Fire hazards are caused by the fifth natural element the Fire.
- The Fire is a process of burning that produces heat, light and often smokes and flames.
- Fire disasters can again be either natural (forest fires) or man-generated (due to bombing).
- It can occur on all three regions- above land in skyscrapers, aeroplanes; on the ground (forest fires); below the ground in mines.

TYPES:

Based on the cause for the outbreak of fire, it can be classified into the following two types:

- **Natural**: It may be caused by volcanic eruptions, damage to power lines and natural gas systems during earthquake. However, it is a complex scenario which occurs rarely.
- **Man-induced**: It may be the result of short circuit in buildings, electronic equipments in large companies, kitchen fires, ignition of flammable substances which are accidental. The fire emanating from garbage wastes due to reaction of chemicals and combustible substances, bombing activities also result in fire which is intentional.

Fire prevention strategies

1. Prevention of fire due to Hazardous chemicals

- Chemicals used and stored in school and college laboratories must adhere to strict Hazards Communication Policies. Safe storage and handling of chemicals is of prior importance to prevent combustible chemicals from producing fire hazards. Thus, these institutions must follow strict guidelines and the staffs handling them should be provided training to handle such chemicals.

2. Safety at home

- Check if you have turned off the gas before leaving home
- If you detect any leakage of gas or short-circuit, turn off your main, open the kitchen windows, alert everyone in the site to leave to open ground and immediately call to fire brigade service
- At kitchen, ensure that oil is not close to combustible substances as it intensifies the fire
- It is always advisable to wear apron or cotton clothes while working in kitchen as nylon or silk materials stick to one's skin on burning.

3. Safety at Work place

- All companies are requested to have fire extinguishers (minimum of one on each floor) so that incase of outbreak of fire it could be immediately put off
- Each and every employee must be taught to operate these fire extinguishers
- For air-conditioned rooms, emergency exits should be created
- Incase of companies dealing with chemicals and electronic equipments it is solely their responsibility to undertake safety measures enumerated in the manual of those chemicals and electronic items
- Unused e-items should be disposed off immediately rather than storing them in a repository.

4. Safety during mass gatherings at an event

- Use decoration items that are non-combustible
- Inspect lighting wires for damaged insulation, bare wires, loose connection
- Ensure that there is no lit candles, the cooking area is away from the gathering
- During festivals like Diwali, take atmost care while bursting crackers. Burst rockets and sky crackers at a high altitude (terrace) or open grounds (most preferable)

Fire mitigation strategies

1. What to do before a Fire?

- Prepare escape routes from the site by analyzing the different ways available with your family. Practice the route if necessary
- Ensure that each room has a fire safety opening feature on windows for exit
- Place fire extinguishers at various places in the building. Test and clean it at regular intervals
- Have a ladder in a storeroom of the apartment to evacuate people from other floors
- Don't smoke indoors particularly near flammable substances
- Store flammable substances like gasoline, kerosene in approved containers
- Keep matchsticks and lighters at a high place away from the vicinity of children

2. **What to do during Fire?**

- Call fire brigade alerting services immediately
- Remember that hot air raises to the top. So, air near floor will be cooler. Try to crawl through any exit
- If you are out of the room that has got fire, keep the door closed and evacuate the room. Do not open it
- If your clothes catch fire instead of running which will only intensify it, cover yourselves with a blanket or roll on the floor till the fire is extinguished

3. **What to do after fire?**

- Do not open any closed boxes immediately after entering the room since it would have been heated and opening it would result in bursting of contents
- On entering the house, if you still detect heat leave the room

Forest fires/Jungle fires

Indian Scenario

- Forests are most prone to fires compared to any other kind of disasters.
- It is the result of flames produced from twigs that settle down on the forest cover during summer.
- Himalayan forests experiences forest fires frequently. Such disaster destroys the flora and fauna in that region thus disturbing the ecosystem.
- Forest fires can in turn be classified into various types namely underground fire, surface fire, ground fire and crown fire.
- Slash and Burn Method of farming- clear a small portion of forest area and burn the vegetation in it for cultivation.
- Forest fires result in huge amount of noxious gases being released into the atmosphere which causes health hazards like respiratory problems and global warming due to increase in the level of carbon monoxide, hydrocarbons. Ultimately it also results in the depletion of ozone layer.

Forest fire prevention

- There is a separate forest department allocated for each and every state and union territory.
- Currently, the Forest Protection Division is implementing a scheme called, Modern Forest Fire Control Methods under which financial assistance is provided for all states in achieving prevention of forest fires.

- Using this, the state is required to obtain firefighting equipments, construction of fire watch towers, fire resistant clothes, propagating the safety measures.

Steps taken by government in preventing fire

From the beginning, government of India has envisaged many different fire safety acts including that of Fire force bill, Fire services bill, Fire prevention and safety act for buildings.

- It had also taken a great step towards incorporating the subject Fire Protection and Control as part of the 7th schedule of the Constitution.
- Explosive rules for fire crackers, creating many awareness programs are some of the credible measures taken by the Government.
- Delhi Prevention act, 1986 was introduced in our capital which checks if all apartments are equipped with firefighting instruments, providing fire safety guidelines at various Fire prevention wings. National Forest policy was adopted in the year 1988.
- The main aim of the policy is:
  "The incidence of the forest fires in the country is high. Standing trees and fodder are destroyed on a large scale and natural regeneration annihilated by such fires. Special precautions should be taken during the fire season. Improved and modern management practices should be adopted to deal with forest fires."

Traffic Accidents

Road accidents

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- Unsafe driving behavior.
- Traffic congestion caused by increased use of private mode of transport and less practice of vehicle pooling.
- Highway capacity shortages
- Lack of valid and fake driving licenses
- Nature of traffic management.

Other factors

- Drivers especially of heavy vehicles operate under inhospitable conditions which induces high levels of stress and possibility of accidents.
- No organized wayside amenities, maintenance and repair facilities.
- Coverage of extra long distances by drivers causing increased mental stress.
- Concessions given to drivers by wayside eateries in the form of free food and alcohol for their own profit.
- Inexperienced, untrained and underage, cyclists on the road with no separate path for them.
- Presence of beggars on busy road junctions and traffic lights.
- Use of mobile phones while driving.
- Drug addiction.
- Presence of wine outlets near the roads.
- Sale of lotteries, helmets etc near roadside.

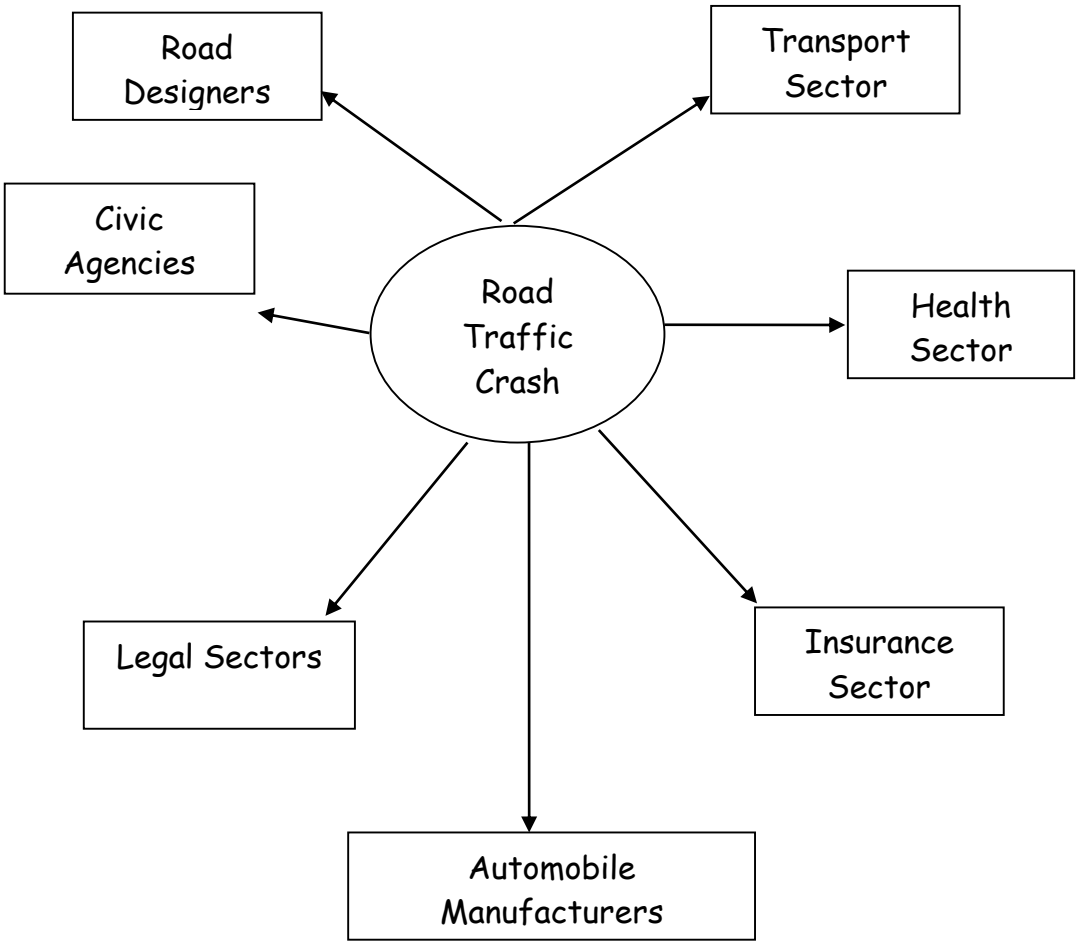
Threats to road safety

- Movement of animals on busy roads
- Flouting of rules by road users.
- No separate pathway for the non motorized transport and pedestrians.
- Poor visibility due to fog.
- Parking of any type of vehicle at own convenience.
- Playing mischief on road while driving.
- Seeking attention on road by playing gimmicks like leaving the handle while driving, standing while driving etc.
- Use of horns with loud and funny noises.
- Listening to loud music etc.

Road Traffic Injuries cause……..

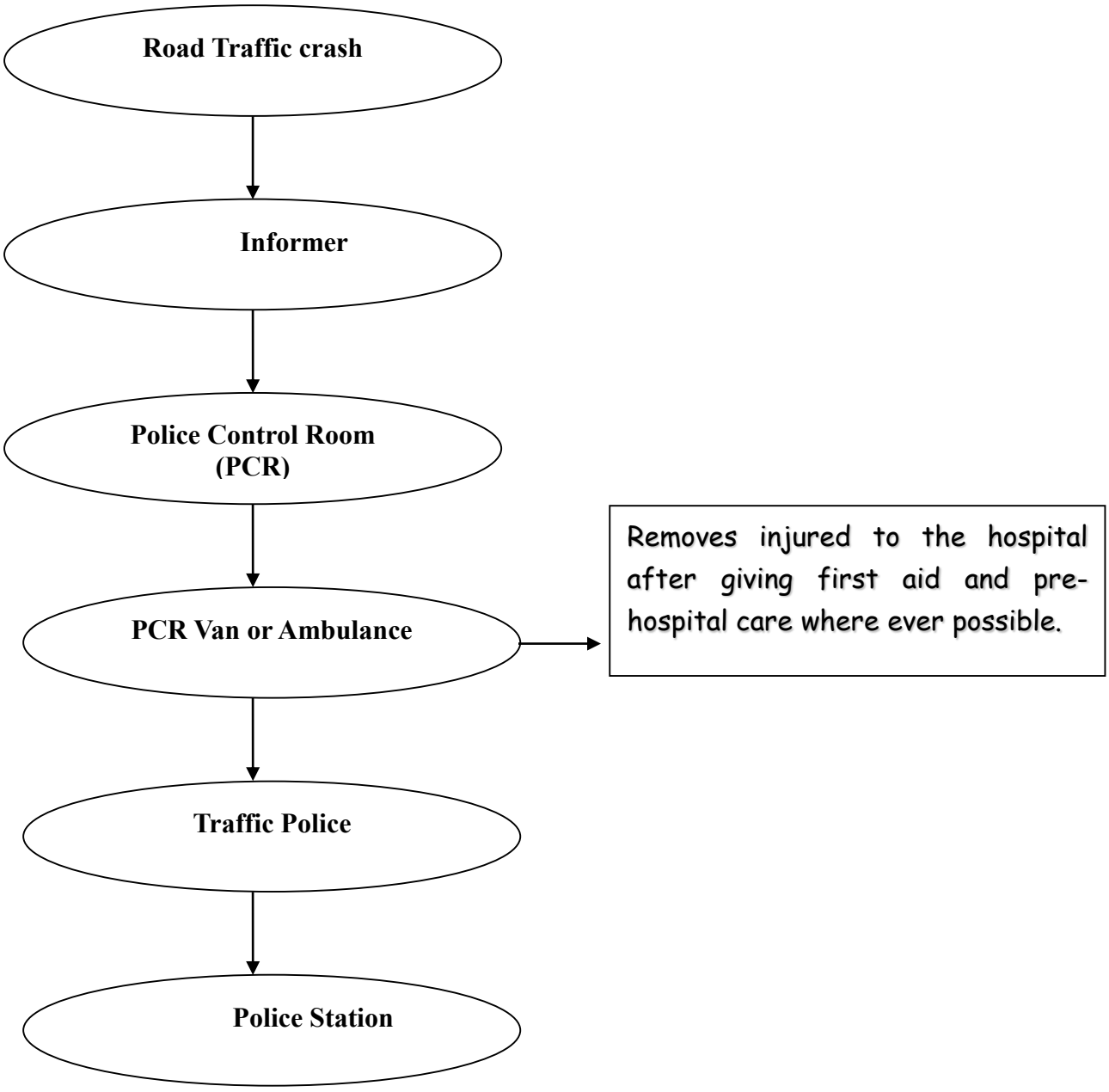
- Death
- Disability
- Hospitalization
- High Social and economic costs which include medical costs, cost related to administration, Legal and police expenditure, collateral damage in terms of damage to property and motor vehicles, loss due to income forgone rising out of absence from work or disability.
- Quality of life of accident survivors becomes poor as they live with pain and suffering.

Multisectorial Involvement in Road Traffic Crash



Complete co-ordination in all these sectors is needed for the rescue, transportation, trauma care and relief, investigation and compilation of data to achieve total road safety in the interest of road users.

Flow of information in case of road traffic crash



Existing Health care setup

- Sub Centres at village level
- Primary Health Centres
- Community Health Centres
- Civil Hospitals
- District Civil Hospitals and Trauma Centres
- Tertiary Care / Referral Hospitals and Medical Colleges with Super specialist set up.
- All through the chain of setup private practitioners are present, who also treat road traffic crash victims and form a very important link in treating and providing data for road traffic crash victims.

Data regarding road traffic crashes and the treatment of crash victims can be collected from all these health set ups.

Post Road Traffic Crash Care

- Main aim is speedy and effective trauma care and management to save life.
- Assistance by by-standers. People are reluctant for the fear that they may be involved in police case. Awareness is now being spread that any body who shifts the traffic crash victims to hospital will not be harassed as per law.
- For any vehicle involved in accident that has caused injury to the person it is the duty of the driver to shift the accident victim to the nearest doctor and report the accident to the nearest police station within 24 hours and the insurance company.
- Any vehicle government or private without any jurisdictional formality should shift the accident victim to the hospital at the earliest to save life even in cases of fatal accidents rather than declaring the victim dead on the spot. There might be hope for him.
- Courteous behavior by police and health staff towards the person who has shifted the crash victim to the hospital.
- Help the crash victim promptly and to the best of your ability. Remember some time it could be you or your near and dear one. Think and act empathetically and try to save life of the victim.

Treatment of the Road Crash Victim

- Thrust is on saving life by providing prompt and best medical care right from the site of accident, during transportation, in hospital and post hospital care period, which may be in form of medication, counseling, rehabilitation and compensation.
- As soon as crash victim is received in emergency prompt treatment is started and according to severity and type of injury treatment / surgical intervention by specialists is done immediately in emergency operation theatres itself and the patient is kept under emergency care post operatively until he stabilizes

and is then shifted to respective ward where he is fully treated and then discharged.

- Medico legal work is done only after initial treatment.
- In case of serious patients treatment even surgical intervention is started without waiting for any relative to come for consent in the interest of saving life of the accident victim. All legal formalities are done at later stage.
- When ever accident victim is shifted to tertiary care hospitals a referral form containing full detail of the injury and physical status of the patient along with treatment given is filled but if patient is very serious he is immediately shifted and emergency of tertiary care hospital is informed telephonically by referring doctor so that every thing is ready there to receive and treat the patient.
- As per law any body accompanying the road crash victim is not to be unduly questioned or harassed to encourage public participation in shifting the road crash victims to hospitals to save life.

Factors Affecting Quality Care of Road Crash Victims

- Crowd of onlookers at the accident site without serving any purpose.
- Lack of adequate spiritual and moral training workshops for casualty doctors and nurses.
- In adequate data on road traffic injuries and their treatment records.
- Incomplete registration of road traffic crashes. Mostly compromise is reached between the crash causing vehicle owner and crash victim and accident case is not reported.
- Due to low awareness level lack of trust by relatives of crash victims in health care facilities being provided leading to frequent shifting of patient and thus affecting his treatment.
- Inadequate link between all health institutions for trauma care and compilation of data.
- It is participative health and social insurance scheme to provide protection to workers in the organized sector and their dependants in contingencies such as sickness, maternity or death and disablement due to an employment injury or occupational disease. This scheme is administered by corporate body called Employee State Insurance Corporation which has its central headquarters at New Delhi.

Role of ESI in treating road crash victims

- It provides all types of care to road crash victims even if the person is not a insured person (IP) with the ESI in order to save life.
- In case of insured person meeting with road accident complete treatment along with sickness benefit for 91 days and extended sickness benefit for 2 years with 50 % and 70 % of wages respectively is given after authentication by designated authorities.

- Any expenditure by the IP in his treatment after road crash is reimbursed by ESI in case he has been treated elsewhere in emergency outside the ESI health network.
- Free supply of physical aids and appliances such as crutches, wheel chairs, dentures, spectacles etc.
- Funeral expenses on death of an IP subject to a maximum of Rs 2500/- payable at branch office.

Road Safety ---- A Responsibility---

- Department of Road Transport and Highways with its head office at New Delhi is responsible for :--
  - Formulation / Implementation of policies for road transport development.
  - Maintenance of National Highways.
  - Transport Research.
  - Updating of norms for road safety.
  - Ensure safe mobility of the road transport system in the country.
  - Administration of Motor Vehicle Act 1988, which lays downs principles and procedures and makes authorities responsible for issue of driving licenses, issue of permits, grant of fitness certificates for vehicles on roads, prescription of emission and safety related norms for motor vehicles, norms for type approval in production of new motor vehicles, issues relating to compensation in case of motor vehicle accidents and compilation of data.

- National Highway Accident Relief Service Scheme (NHARSS):--
  - Under this scheme crash victim is shifted to nearest hospital, medical assistance is provided, damaged vehicle is removed from site, cranes and ambulances are given to NGOs and state authorities.

Road Safety – A Challenge:--

- There is a need to monitor driver training school regarding their infrastructure, equipment, quality control, qualified driver training instructors, strict code for issue of driving licenses, regular and random health checkups of drivers along with counseling sessions, checking for any drug and alcohol addiction, overloading, over speeding and refresher training for existing drivers.
- Need for parking spaces and truck terminals outside the cities to reduce traffic crashes.
- Need to avoid using mobiles while driving.
- Need to use helmets and seat belts while driving.
- Need to design roads in a way that even if a person is wrong the system does not permit him to do that wrong.

- Need to strictly enforce yellow colour code for school buses and to regulate their speed.
- Need for stress free driving, avoid driving while under stress.

Road Safety Awareness Measures

Organization of road safety weeks, seminars and exhibitions.

- Display of banners and distribution of pamphlets on road safety.
- Telecasting and broadcasting of TV spots / Radio Jingles.
- Organizing Essay Competitions, Declamation Contests on Road Safety.
- Printing of calendars, stickers, posters containing road safety measures.
- Display of road safety slides in cinema halls.
- Organizing street plays on road safety.
- Organizing workshop cum training programs on road safety management, road transport regulation and planning.
- Display of road signs and Do's and Don'ts regarding road safety at important locations / traffic junctions to inculcate road discipline.
- Special training for school and college students for sensitization to traffic rules.
- Involvement of NGOs, print, audio and audio visual media in all the above activities.
- Organizing rallies to create awareness on road safety measures.

Rail accidents

- Railways are a mode of transport essential to the daily life of the people, as they can transport vast amounts of people and goods speedily and on time.
- A single accident can not only seriously interfere with the convenience of commuters but also cause immense damage.
- Therefore, the nation needs to promote various safety policies and establish a trust in railway transport among the people.
- Fire, collision, derailments and unmanned railway crossings are major reasons for the rail accidents.

Indian railway network

- One of the most prestigious service provided by the Indian government.
- Railways were first introduced to India in 1853. Overseen by ministry of railways.

- It is the largest rail network in Asia and world's second carrying 18 million people to their destinations each day. More than 16,000 trains run on Railway tracks each day.
- As of May 2014, the Railway Ministry is headed by Suresh Prabhu and assisted by two ministers.
- Indian railway is divided into16 zones. It is again subdivided into 67 divisions.
- Indian Railways lack funds for investment. Accident rate is very high and needs immediate attention.

Classification of Railway accidents

- in terms of effect:
- **Head-on collisions**: A head-on collision is a traffic collision where the front ends of two vehicles such as cars, trains, ships or planes hit each other in opposite directions
- **Rear-end collisions**: A rear-end collision is a traffic accident wherein a vehicle crashes into the vehicle in front of it.
- **Derailments**: A derailment is said to take place when a vehicle runs off its rails.

Classification by causes

- Drivers' errors
- Passing signals at danger
- Excessive speed
- Mishandling engine
- Signalmen's errors
- Allowing two trains into same occupied block section
- Incorrect operation of signals
- Mechanical failure of rolling stock
- Poor design and Poor maintenance
- Track faults
- Bridge and tunnel collapses

- Other railway personnel
- Non-railway personnel
- Accidental
- Trespassing
- Strength of rolling stock
- Fires resulting from accidents
- Effectiveness of brakes
- Poor track or junction layout
- Inadequate rules
- Level crossing misuse
- Other
- Fires and explosions (including sabotage/terrorism)
- Falls from trains, collisions with people on tracks
- **Low investment** – For the past 20-23 years the Indian Railway is carrying 15 times more people than its capacity. Overloading is certainly damaging the old tracks which have life of their own.
- Most of the Indian trains are not equipped with fire detection systems.
- In some nations devices to automatically stop the train if it crosses red signal are in place. These avert head on collisions to a great extent. But no such devices are provided in Indian Railways leading to certain avoidable collisions.
- **Human errors** – The Indian Railways lacks new technologies, therefore chances of human error are more and it is one of the major causes of rail accidents in India.
- Reasons why safety measures are compromised are low investment, delay in installing anti-collision devices and shortage in manpower.
- Manual signaling system between stations must be replaced with automated one.
- **Unmanned crossings** – 15,000 crossings out of 50,000 in India are unmanned. Road users do not take proper precautions and cross lines even if the signal is red leading to accident. Overpass bridges, flyovers and fencing is done to reduce the accidents.

Commission of Railway Safety (CRS)

- The Commission of Railway Safety (CRS) , working under the administrative control of the Ministry of Civil Aviation of the Government of India, deals with matters pertaining to safety of rail travel and train operation
- It is charged with certain statutory functions as laid down in the Railways Act (1989), which are of an inspectorial, investigatory & advisory nature.
- The Commission functions according to certain rules viz. statutory investigation into accidents rules framed under the Railways Act and executive instructions issued from time to time.
- The most important duties of the Commission is to ensure that any new Railway line to be opened for passenger traffic should conform to the standards and specifications prescribed by the Ministry of Railways and the new line is safe in all respects for carrying of passenger traffic.
- This is also applicable to other works such as gauge conversion, doubling of lines and electrification of existing lines.
- Commission also conducts statutory inquiry into serious train accidents occurring on the Indian Railways and makes recommendations for improving safety on the Railways in India.

Institutional arrangements

Need for establishment of

- National Railway Safety Research Institute (NRSRI) – multidisciplinary, at least 50% staff permanent with research qualifications
- Endowed chairs in research institutions for independent basic and futuristic research on railway safety in coordination with NRSRI

National Railway Safety Research Institute (NRSRI)

- ❑ Must be independent of investigation and standards enforcement agencies
- ❑ Safety research – institutional linkages and training
- ❑ Laws, operations and management
- ❑ Capacity Building

- ❑ User behaviour strategies, public awareness education, conferences/workshops
- ❑ Designing, setting standards and conducting audits

Railway traffic safety

Objectives of Railway Traffic Safety

- To reduce the number of passenger fatalities to zero.
- To reduce the number of operations accidents.
- Achieving a Society with no railway accidents.
- Various safety measures must be promoted so as to develop public confidence in railway services

Measures to be taken involve:

1) Solving specific problems underlying past individual accidents

2) Utilizing lessons learned from past accidents

Six pillars

i)Improving the railway traffic environment
ii)Securing safe railway operation
iii)Ensuring railway vehicle safety
iv)Enhancing rescue and emergency services systems
v)Promoting victim support
vi) Enhancing R&D and study activities

Aircraft accidents

- Located at Rajiv Gandhi Bhavan at the Safdarjung Airport in New Delhi, the Ministry of Civil Aviation is responsible for formulation of national policies and programmes for the development and regulation of the Civil Aviation sector in the country.
- It is responsible for the administration of the Aircraft Act, 1934, Aircraft Rules, 1937 and various other legislations pertaining to the aviation sector in the country.

- This Ministry exercises administrative control over attached and autonomous organizations like the Directorate General of Civil Aviation, Bureau of Civil Aviation Security and Indira Gandhi Rashtriya Udan Academy.
- It is affiliated to Public Sector Undertakings like National Aviation Company of India Limited, Airports Authority of India and Pawan Hans Helicopters Limited.
- Air crashes have wide-ranging and often tragic consequences. They occur usually because of a chain of connected causes.

Why do planes crash?

- There are many reasons why planes crash. The people who build, maintain or fly aircraft can make mistakes or wrong decisions. Also, weather conditions such as fog and strong winds can make flying unsafe.
- Small aircraft such as top-dressing planes and helicopters are more likely to crash. Often they fly in risky conditions – low over rough countryside or in changeable weather.

Human error

- Human error is the underlying cause in the majority of aircraft accidents.
- The person at fault may be a pilot, maintenance engineer, ground crew member, manager or supervisor, designer, or someone involved in the manufacture of an aircraft.
- Errors on the ground can include faulty aircraft construction or maintenance, incorrect instructions to air crew, mistakes in refuelling or securing the aircraft doors, overloading, and excessive stress on staff.
- In the air, pilots may make navigation errors, or choose to fly in cloudy conditions using visual cues such as landmarks instead of navigational instruments.

Weather

- Very powerful storms might be able to seriously damage the wings on a aircraft but, typically, pilots and air traffic controllers make great effort to avoid them.
- It may also be due to the mountainous terrain and the prevalence of strong winds and turbulence.
- The Directorate General of Civil Aviation (DGCA) is the regulatory body in the field of Civil Aviation, primarily dealing with safety issues.
- It is also responsible for regulation of air transport services to/from/within India and for enforcement of civil air regulations, air safety, and airworthiness standards. The DGCA also co-ordinates all regulatory functions with the International Civil Aviation Organisation (ICAO).

Registration of civil aircraft

- Formulation of standards of airworthiness for civil aircraft registered in India and grant of certificates of airworthiness to such aircraft
- Licensing of pilots, aircraft maintenance engineers and flight engineers, and conducting examinations and checks for that purpose;
- Licensing of air traffic controllers
- Certification of aerodromes and CNS/ATM facilities;
- Granting of Air Operator's Certificates to Indian carriers and regulation of air transport services operating to/from/within/over India by Indian and foreign operators, including clearance of scheduled and non-scheduled flights of such operators.
- Conducting investigation into accidents/incidents and taking accident prevention measures including formulation of implementation of Safety Aviation Management programmes.
- Carrying out amendments to the Aircraft Act, the Aircraft Rules and the Civil Aviation Requirements for complying with the amendments to ICAO Annexes, and initiating proposals for amendment to any other Act or for passing a new Act in order to give effect to an international Convention or amendment to an existing Convention;
- Coordination at national level for flexi-use of air space by civil and military air traffic agencies and interaction with ICAO for provision of more air routes for civil use through Indian air space;
- Keeping a check on aircraft noise and engine emissions in accordance with ICAO Annex 16 and collaborating with the environmental authorities in this matter, if required;
- Promoting indigenous design and manufacture of aircraft and aircraft components by acting as a catalytic agent;
- Approving training programmes of operators for carriage of dangerous goods, issuing authorizations for carriage of dangerous goods, etc.

The Bureau of Civil Aviation Security (BCAS)

- The BCAS was reorganized into an independent department under the Ministry of Civil Aviation on 1st April, 1987.
- The main responsibilities of BCAS include laying down standards and measures with respect to security of civil flights at international and domestic airports in India. BCAS Head quarter is located at "A" Wing, I-III floor, Janpath Bhavan, Janpath, New Delhi-110001.
- It has got four Regional Offices located at International airports i.e. Delhi, Mumbai, Kolkata and Chennai.
- Laying down Aviation Security Standards in accordance with Annex 17 to Chicago Convention of ICAO for airport operators, airlines operators, and their security agencies responsible for implementing AVSEC measures

- Monitoring the implementation of security rules and regulations and carrying out survey of security needs.
- Ensure that the persons implementing security controls are appropriately trained and possess all competencies required to perform their duties.
- Planning and coordination of Aviation security matters.
- Surprise/Dummy checks to test professional efficiency and alertness of security staff.
- Mock exercise to test efficacy of Contingency Plans and operational preparedness of the various agencies.

Navigation systems

- A nationwide network of radio beacons, distance-measuring equipment, and instrument landing systems at airports enables pilots to fly safely to their destinations.
- Air traffic controllers use radar to provide crucial advice to pilots before and during flight.
- Large aircraft carry sophisticated navigation equipment, and even light aircraft have some navigation aids.
- The latest global positioning system (GPS) involves computer conversion of signals from a network of satellites, to provide the pilot with highly accurate information on aircraft position.

Bomb detection and prevention

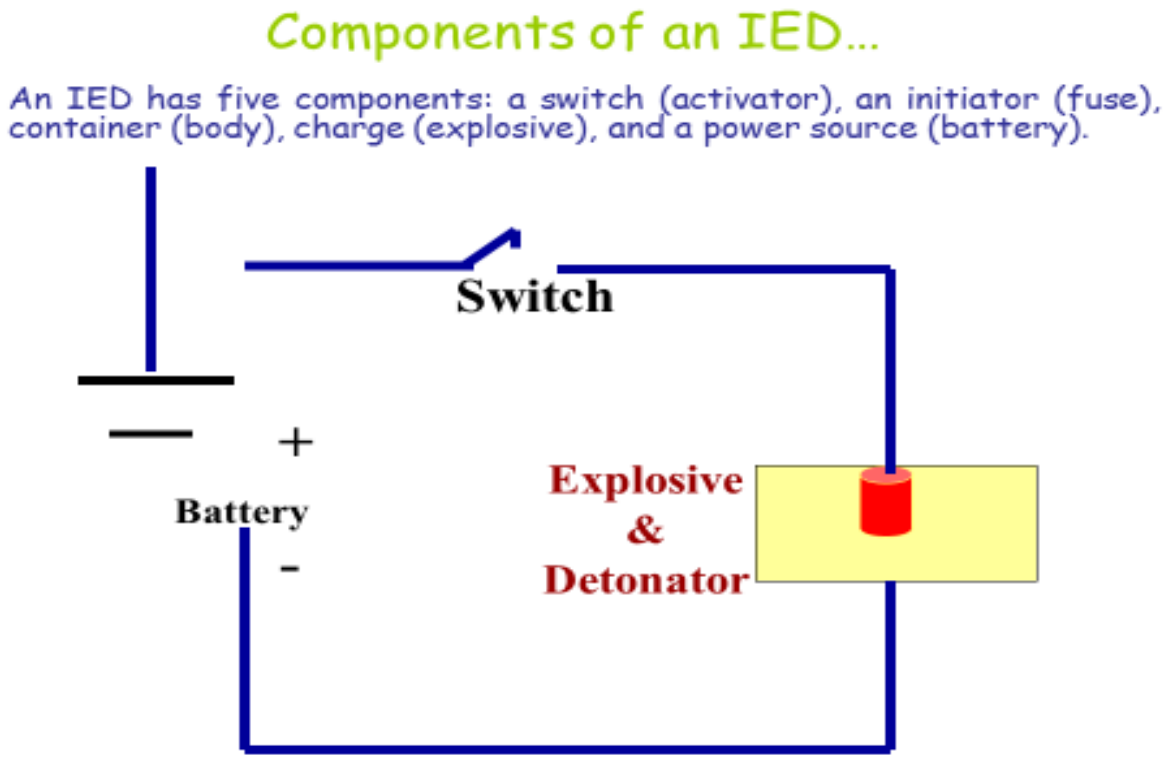
- Initiated explosives have killed thousands of people and injured several tens of thousands.
- Infrastructural facilities, like railway stations, airports, underground railways, water supply, etc. are preferred targets involving up to thousands of people.
- New forms of bomb attacks are more sophisticated, more dangerous, using remote control of Improvised Explosive Devices (IED); initiation by mobile phones permits terrorists to initiate a bomb immediately.
- Therefore, detection systems with a reliable detection efficiency used in broad range of IEDs are an important problem.

What is a bomb??

- These are devices either factory made or home-made.
- It is one of a range of explosive weapons that only rely on the exothermic reaction of an explosive material to provide an extremely sudden and violent release of energy.
- These are used to create fire, shock, heat and gas to cause extensive damage to the target.

What is an IED????

- An improvised explosive device (IED) is a bomb constructed and deployed in ways other than in conventional military action. IEDs are commonly used as roadside bombs.
- IEDs are generally seen in heavy terrorist actions or in unconventional warfare by guerrillas or commando forces in a theatre of operations.
- The effects of an IED explosion are not standard and predictable
- The effects will vary in each case, depending on :
    - Components
    - Quality of explosive
    - Casing
    - Quantity of splinters



Why IED is extensively used???

- An IED designed for use against armoured targets such as personnel carriers or tanks.
- The attraction of the IED is that it allows an opponent to be attacked, often remotely.
- It has to work only once
- It can produce multiple deaths in spite of its small size.
- They are easy to place and conceal.

How are IEDs used???

- IEDs are extremely diverse in design, and may contain many types of initiators, detonators, penetrators and explosive loads.
- Antipersonnel IEDs typically also contain fragmentation-generating objects such as nails, ball bearings or even small rocks to cause wounds at greater distances.
- IEDs are triggered by various methods, including remote control, infrared or magnetic triggers, pressure-sensitive bars or trip wires.
- In some cases, multiple IEDs are wired together in a chain, to attack a convoy of vehicles spread out along a roadway.

What are the likely targets?

- Passengers on public transport, ship, train or aeroplane.
- Audience of meeting, cultural, social or religious gathering.
- Employees of big offices.
- Public at shopping centre, Mall and hotels.
- Public at the confined areas like under pass, railway stations, bus stands, theatres etc.
- Children at schools and other populated areas.

Initiation Mechanism

The switch is a mechanism incorporated to ensure initiation of an IED in a predetermined pattern so as to ensure success in destroying the target in a well deliberated manner.

Counter-IED efforts

- Counter-IED efforts are done primarily by military, law enforcement, diplomatic, financial, and intelligence communities and involve a comprehensive approach to countering the threat networks that employ IEDs, not just efforts to defeat the devices themselves.

Recognition of an IED and appropriate response

- Security personnel and all employees shall look for the items which are out of the ordinary.
- Luggage, brief case or packages which are left unattended.
- Items which do not conform to their surroundings.
- Loose and clean wires on vehicles.
- New items of unexplained origin.
- Suspicious packages inside of underneath or attached to vehicles.
- Check out unusual behavior of individuals.
- Surveillance of the premises.
- Unexplained and unexpected deliveries.

Detection systems

- A variety of technologies are used to detect improvised explosive devices (IED) and unexploded ordnance (UXO), including:
- acoustic sensors,
- animals and biologically-based detection systems,
- chemical sensors,
- electromagnetic sensors and hyper spectral sensor analysis,
- generalized radar techniques,
- ground penetrating radar,
- lidar and electro-optical sensors ,
- magnetic signatures,
- nuclear sensors, optical sensors, seismic acoustic sensors, and
- thermal detection.

- **Microwave Based Explosive Caches Detection**: This vehicle-mounted stand-off system provides high-definition IED detection, confirmation and threat diagnostics from a significant distance.
- **Non-linear Junction Detector (NLJD)**: A portable NLJD allows the operator to search voids and areas where they are unable to gain physical or visual access, in order to detect electronic components and determine if the area is free from IEDs.
- **Laser IED Detection**: Scientists are learning to adapt lasers to detect, or defeat, IEDs.
- **Mine detectors**: A portable, hand-held or worn device to detect buried IEDs.

Bomb Threat Counter Measures

- CCTv Camera- Sensitive areas like the main entrance, perimeter, reception room, mail room, and other areas which need surveillance/ coverage may have CCTv camera both exposed/ unexposed depending upon the need and situation.
- Intruder Alarm- Mere surveillance through CCTv camera is not enough because a user may need to respond to undetected movement of suspects or would like to apprehend him, in such cases they may install intruder alarm system at the perimeter or vulnerable areas where suspects are likely to drop bombs/ explosives.
- Illumination- By proper illumination system a user may detect dropped bomb which would otherwise be difficult to detect during darkness.
- Patrolling- Patrolling along the perimeter and around solitary areas may help detect bomb.
- Search/ check – Physical search and check of personnel bag, brief case and luggage can help detect bomb/ explosives.

- Scanner and detector- X-ray machine and metal detectors installed at the main gate help detect bomb/ explosives.
- Inspection Mirror- Vehicle search and use of long handled mirror used underneath of vehicle can help detect bomb/ explosives.
- Barrier- To avoid parking of car bomb or to avoid rushing of vehicle loaded with explosives into an establishment, the approach to main gate and perimeter to have physical barriers to deny parking/ rushing of vehicle loaded with explosives.
- The barriers could be constructed with Cement, Brick or Drums fills with sand etc. User may plant flowering trees on it to cover the barriers.
- Luggage Locker- Use of luggage locker for visitors at the reception can prevent bomb threat. This can be done by searching luggage while issuing key and token to the visitor.
- Meeting visitor at reception– If visitor are met at the reception instead of taking them to the employees desks; bomb threat can be prevented.
- Fixing wire mesh at the widow- Closing unnecessary window, ventilator and opening and fixing wire mesh at the window, ventilator and other openings at the ground floor may prevent bomb threat.
- Separating Mail Centre- By making mail centre separate and away from the main building, bomb threat can be prevented

General Prevention Measures

- Making the offices/residences at a safe distance, 300 feet from perimeter.
- Denying parking of vehicle of visitors/ strangers beside the perimeter by making barriers.
- Making fencing, lighting and controlling access and searching bag, brief case etc, through metal detector and X-Ray detector.
- Putting the Bag/ Briefcase into the reception and inside visitors lockers at a safe distance from main building of office/ residences.
- Inspection of all packages can reduce bomb threat. Installing surveillance and detection devices and CCTV camera at all entrances and likely places where bomb may be placed.
- Intruder/ Burglar alarm can be effective if any one approaches undetected to keep bomb inside an office/ residence.
- Heavy wire mesh and steel shutter on window can be very effective against lobbying bomb/ Explosives.
- Surveillance should be carried out to the potential hiding places (like stair walls, rest rooms and vacant spaces) to find out unwanted individuals.
- Vulnerable areas such as generator, power room, boiler house, mail rooms, telephone exchange, computer areas, switch board rooms and lift control rooms should be kept under lock and key where not manned.
- Good house keeping can reduce bomb threat. Trash and dumpster areas should remain free of debris. A bomb can easily be concealed in side the trash.

- Combustible materials should properly be disposed off or preserved if further use is necessary.
- Meeting visitors at the reception can substantially reduce the risk of bomb attack.
- Display of notice for inspection of package, bag, brief case and search of visitors

- Awareness- Awareness among public can also help detect bomb/ explosives by suspected personnel, luggage and vehicle.

Action on Bomb Blast

Second bomb Blast: Normally a bomb blast or a number of bomb blast is followed by second bomb blasts to injure the rescuers or curiosity seekers. So, after a bomb blast everybody should remain alert about second blast.

Rescue operation:

- Panic Control- Panic must be controlled once news of bomb blast is received or bomb is detected.
- Systematic evacuation and search will be difficult unless people are previously briefed and assured during crisis that situation is under control.
- Concerned person may speak over PA equipment or convey message to department heads, to control panic within respective employees.

Evacuation of Employees- Evacuation plan should include the following:

- Normally all person should be evacuated to a distance of 400 feet.
- But if the device contains explosive more than 2.5 pounds, their distance should be tripled.
- Emphasis must be given to prevent panic because panic is the worst enemy to successful evacuation.
- Factual statement as to what happened to be shared.
- Calm assurance to be given that nothing to be panicked, situation is under control.
- Orderly evacuation will allow everybody to go to safe zone without blocking exit/ gates.
- Rush anarchy and disorder will block ways and prevent escape to safety.
- Guard should be deployed around the danger area. However, to save man power, items like portable barrier, ropes, sign posts, to be assembled earlier for emergency use.

- Entry and exit route (Traffic circuit) for vehicle and personnel must be made and manned by security personnel and ensure proper traffic control around the bomb site.
- Use common sense to meet unforeseen developments

- Cordon- A bomb blast site to be cordoned by security personnel or by other employees to guard against theft, plundering or stealing of valuable material or destroying evidences.
- Salvage property- After a bomb blast, efforts should be made to salvage intact and damaged property to a safe place.
- Counting of employees- After evacuation on bomb threat or after blast, all employees assembled at assembly area to be counted to ascertain death/ injury of employees.
- Record of statement of witness- Immediately after the blast, victim if survived or eye witnesses should be interviewed. Preferably their inter view should be recorded through video camera/ audio device for future investigation.
- Informing Law enforcing Agencies- Immediately after bomb blast local police should be informed of the incidence. If situation demands other law enforcing agencies as deemed necessary may be informed in consultation with local police.
- Informing Fire Fighting Agencies- In case of bomb blast needing assistance from civil defense and fire fighting agencies, they may be informed.
- Handling Press/Media People- It is very important to handle the news media. They should be handled by a pre-selected spokes person or responsible personnel authorized by the management.
- Every body should not try to talk to them indiscriminately. This is risky as careless and tact less comment may lead to trouble for the organization.
- They should be encountered politely, tact fully and given due attention and try to give factual information without any irresponsible comment or un-confirmed message.
- No information should be disclosed which may compromise the investigation of the incidence. The preparation of press release should be coordinated with top management and the police. Initial release may contain factual statement of incident but no details. General wording of such release may be written earlier.
- Investigation- Every case of bomb blast must be investigated. The investigation committee should be formed without wasting time so that evidence and witness are not allowed to destroy and disappear. The

investigation committee should comprise of technical personnel to under stand the technical aspects of the investigation.

- Assessment of Loss/Damage- Same investigation committee may assess the damage or loss. But a separate committee may also be formed depending on the situation and desire of the management.

Conclusion

- Bomb threat has increased alarmingly in the country recently. This has become a cause of concern for everybody. Even woman, children and elderly people are also not spared. Nobody is now free of danger from bomb threat. We being the working people are likely to be the victim of bomb blast any time anywhere.
- It is thus important for us to know bomb threat its detection and preventive measures. If we are aware and can take appropriate detection and prevention measures against bomb threat, we can save our life and reduce damage to our property.

2013 blast at Hyderabad

- On 21 February 2013, at around 19:00 IST, two blasts occurred in the city of Hyderabad, India. The bombs exploded in Dilsukhnagar, a crowded shopping area, within 100 metres of each other.
- The first explosion occurred outside a roadside eatery named A1 Mirchi, next to the Anand Tiffin Centre and opposite the Konark movie hall, followed by the second one two minutes later near the Route 107 bus stand close to the Venkatadri theatre.
- The first bomb went off at Anand Tiffins, located opposite Konark Theatre at around 19:02. The second bomb went off at 19:06 IST between Venkatadri Theatre and Dilsukhnagar Bus Stand.
- According to the Hyderabad Police, the bombs were placed on bicycles.
- The blasts killed 17 people, which included at least three college students and at least 119 injured.
- A team of forensic experts from the National Investigation Agency (NIA) and the National Security Guard (NSG) arrived in Hyderabad on a plane provided by the Border Security Force (BSF) for further investigation.
- Home Minister Sushilkumar Shinde claimed that the Indian government had intelligence about possible blasts, but the information wasn't specific enough to pinpoint the location of the blast site.
- Shinde also said that authorities had received intelligence about possible attacks in the country but no specific information as to where or when they might occur.

- CNN-IBN reported that an Indian Mujahideen operative named Maqbool confessed to carrying out reconnaissance of Dilsukhnagar in 2012 during interrogation by Delhi Police.
- Initial reports also suggested the involvement of Indian Mujahideen in the blasts. On 22 February, two First Information Reports (FIR) were lodged probing the attack. One FIR was lodged at Cyberabads Saroor police station, while the second was lodged in Hyderabad.
- As the Hyderabad Police continued investigating in the serial blasts case, they detained six people for questioning. The NIA conducted raids at various places in Uttar Pradesh, Bihar and Maharashtra, looking for alleged terror modules.
- Forensic investigation revealed that the two bombs used were packed with huge amounts of iron nails and bolts and ammonium nitrate, which were held together with a copper string.
- Closed-circuit television footage collected from the traffic signal near the blast site revealed movements of five men who allegedly had planted explosives at the blast sites. However, the faces of the suspects were not clearly seen.
- Police sources later said that a Sai Baba temple in the area was the initial target of the criminal activity. However, a visit by Hyderabad police commissioner Anurag Sharma eluded them and forced them to change their target.
- The Andhra Pradesh government claimed that it had obtained vital clues regarding the crime and would crack the case soon. Chief minister Reddy sent out 15 special teams of Andhra Pradesh police, consisting of 10–15 personnel each. People lodged in the Chanchalguda Central Jail were also questioned regarding the blasts.

UNIT IV

Use of remote sensing and GIS in disaster mitigation and management; Scope of application of ICST (Information, communication and space technologies in disaster management, Critical applications& Infrastructure; Potential application of Remote sensing and GIS in disaster management and in various disastrous conditions like earthquakes, drought, Floods, landslides etc.

Introduction

- Natural disasters and calamities throw up major challenges for national governments in many countries.
- In such serious disaster situations, the major challenge for authorities is the protection of life, property, and the vital life-supporting infrastructure necessary for disaster mitigation. Any delay in disaster relief could escalate the magnitude of distress for the victims.
- Specific technological solutions can be utilized in all the phases of disaster management. Traditionally, disaster management makes use of indigenous and locally developed appropriate technologies to a great extent. But many of these technologies and methods have only restricted applicability and possess limited potential to reduce the impact of disasters.
- Hence the need arises for the application of modern technologies in disaster management, wherever and whenever possible.
- Geo-informatics has been successfully used in preparing, planning, analyzing, forecasting, mitigation and risk assessment of various types of disasters.
- Many frontier areas such as space technology, modern information and communication systems, renewable energy, advanced medical diagnostics, and remotely operated robotic systems for rescue and relief operations, find useful applications in disaster management efforts.
- A number of advanced technologies and equipments that have already entered the marketplace in recent years could provide vital support to disaster management programmes.
- Information, communication, and space technologies (ICST), have wide-ranging applications in disaster preparedness, reduction, mitigation, and management.
- ICSTs provide vital support for disaster management in many ways: observation, monitoring, data collection, networking, communication, warning dissemination, service delivery mechanisms, GIS databases, expert analysis systems, information resources etc.
- ICSTs, especially remote sensing, have successfully been used to minimize the calamitous impact of disasters in all phases of disaster management.

ICSTs in disaster management

The wide spectrum of ICSTs used in disaster preparedness, mitigation, and management include:

- Remote sensing
- Geographical Information System (GIS)
- Global Positioning System (GPS)
- satellite navigation system
- satellite communication
- amateur and community radio
- television and radio broadcasting
- telephone and fax
- cellular phones
- internet, e-mail and
- special software packages, on-line management databases, disaster information networks.

Scope of Applications

Disaster management professionals depend on ICSTs for critical solutions during almost all phases of disaster management:

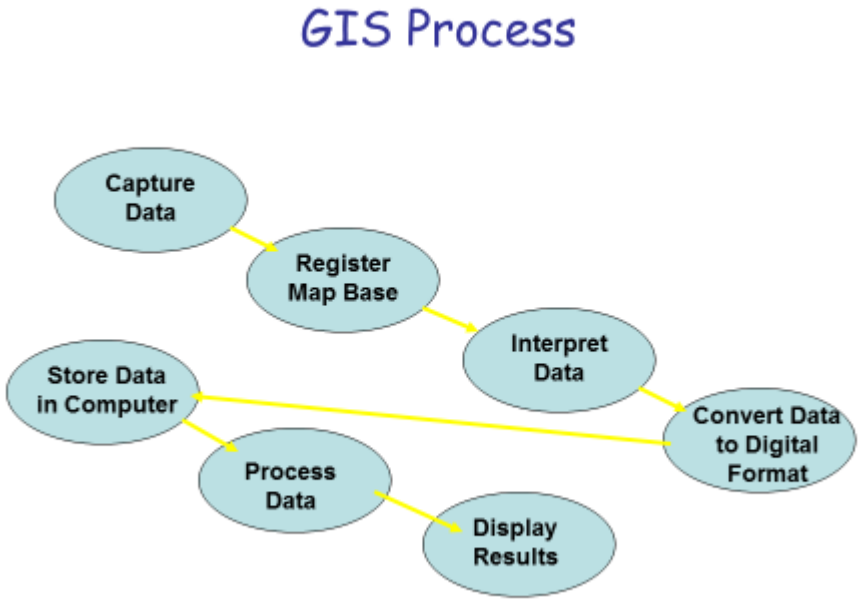
- disaster early warning, dissemination, and evacuation
- disaster information, quick processing and analysis
- database construction
- information integration and analysis
- disaster mapping and scenario simulation
- hazard assessment and monitoring
- disaster trend forecasting
- vulnerability assessment
- emergency response decision support
- planning of disaster response, reduction, and relief
- logistics preparation for disaster relief
- needs assessment for disaster recovery and reconstruction
- risk investigation and assessment
- disaster loss assessment
- monitoring of recovery and reconstruction and rehabilitation.

ICST Infrastructure

- ICSTs are used mainly for collecting, analyzing, and disseminating disaster data and information for utilization by different stakeholders.
- This infrastructure broadly consists of the following components:
- adequate number of observatory stations and satellites at suitable places and facilities
- adequate number of high-tech sensors and measurement instruments which can record, process, judge, and transfer data
- data centres with very high-tech computer systems for Supervisory Control and Data Acquisition (SCADA) for saving, processing, and monitoring collected data and
- adequate number of data dissemination equipment and devices.

Geographic Information Systems

- A GIS is a particular form of Information System applied to geographical data.
- An Information System is a set of processes, executed on raw data to produce information which will be useful when making decisions.
- A system is a group of connected entities and activities which interact for a common purpose.
- An information system has a full range of functions to:
    - process observations
    - process measurements
    - provide descriptions
    - explain data
    - make forecasts
    - make decisions
- A GIS is an organized collection of computer hardware, software, geographic data, and personnel to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.
- A GIS integrates spatial and other kinds of information within a single system to provide a consistent framework for analyzing geographic (spatial) data.
- A GIS makes connections between activities based on geographic proximity.
- The digital data structure can be conceptualized as a set of "floating electronic maps" with a common registration allowing the used to "look" down (drill down) and across the stack of maps.



Principle

- Data Capture: Data sources are mainly obtained from manual digitization and scanning of aerial photographs, paper maps, and existing digital data sets.
- Database Management and Update: data security, data integrity, and data storage and retrieval, and data maintenance abilities.
- Geographic Analysis: The collected information is analyzed and interpreted qualitatively and quantitatively.

- Preparing Result: One of the most exciting aspects of GIS technology is the variety of different ways in which the information can be presented.

GIS as a powerful tool for Disaster Management

- GIS has emerged as a very important tool for effective planning, communication, and training in the various stages of the disaster management cycle.
- The prime concern during any disaster is the availability of the spatial information, and the dissemination of this information to all concerned.
- Internet-based GIS can play a key role in this aspect by providing cost-effective information at various stages of the disaster life cycle, with a much wider reach.
- Access to information is crucial for the effective management of disasters. All those who are concerned with managing disasters necessarily have the need to access timely and accurate information.

- Normally, a considerable amount of money is spent on just finding the relevant information. This happens because the information is stored redundantly in several places and in several formats.
- Maps and spatial information are important components of the overall information in case of any disaster event (flood, earthquake, cyclone, landslide, wildfire, famine etc). Hence mapping and spatial information acquisition becomes vital for any disaster management effort.
- In general, GIS can be used in any part of the disaster management cycle; namely disaster preparedness, response, recovery and mitigation. But one important need for any disaster management effort is to have the spatial information accessible to a larger group of people, in a fast, easy and cost-effective manner.
- The use of GIS on the web can help a lot in achieving these objectives.

Potential Application of GIS in DMM

- GIS is normally used for scientific investigations, resource management, and development planning.
- The analytical capabilities of GIS support all aspects of disaster management: planning, response and recovery, and records management.
- The system facilitates the ordering of the voluminous data needed for the assessment of hazard and risk, and uses models to combine different kinds of data.
- The combination of different kinds of spatial data with non-spatial data and attribute data provides useful information at the various stages of disaster management.

The most common applications of GIS in disaster management are the following:

- GIS provides a versatile platform for Decision Support by furnishing multilayer geo-referenced information, which includes hazard zoning, incident mapping, natural resources and critical infrastructure at risk, available resources for response, real-time satellite imagery, etc.
- Such ready information allows disaster managers to quickly assess the impact of the disaster/emergency on a geographic platform and plan adequate resource mobilization in the most efficient way.
- The specific GIS applications in the field of risk assessment are:
- Hazard Mapping to indicate earthquakes, landslides, floods, fire hazards and tropical cyclones; across cities, districts, or even the entire country, and
- Threat Maps, which are used by meteorological departments to improve the quality of the tropical storm warning services and quickly communicate the risk to potential victims.
- Disaster preparedness phase, GIS is used as a tool for the planning of evacuation routes, for the design of centres for emergency operations, and for

integration of satellite data with other relevant data in the design of disaster warning systems.

- Disaster relief phase, GIS is extremely useful, in combination with GPS, in search- and-rescue operations in devastated areas where such operations are difficult.
- Disaster rehabilitation phase, GIS is used to organize the damage information and the post-disaster census information, and in the evaluation of sites for reconstruction.
- GIS facilitates the calculation of emergency response times for emergency planners in the event of a natural disaster. Such information can be shared easily with disaster response personnel to help coordinate and implement emergency efforts.
- A reliable GIS-based database will ensure the mobilization of the necessary resources to the right locations within the least response time. Such a database would also play a fundamental role in the planning and implementation of large-scale preparedness and mitigation initiatives.

Applications of RS and GIS in various disaster situations

Drought:

- Remote sensing and GIS can be used to develop early warnings of drought conditions which would help in planning the strategies for relief work.
- Satellite data may be used to target potential groundwater sites for well-digging programmes. Satellite data provides valuable tools for evaluating areas prone to desertification.
- Film transparencies, photographs, and digital data can be used for the purposes of locating, assessing, and monitoring the deterioration of natural conditions in a given area.

Earthquake:

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

Floods:

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

Landslide:

- A landslide zonal map demarcates the stretches or area of varying degree of anticipated slope stability or instability. As the map has an inbuilt element of forecasting, it is of a probabilistic nature.
- Depending upon the methodology adopted and the comprehensiveness of the input data used, a landslide hazard zonal map is an excellent information aid in respect of location, extent of the slope area likely to be affected, and rate of mass movement of the slope mass.

Search-and-Rescue:
GIS can be used in carrying out search-and-rescue operations in a more effective manner by identifying areas that are disaster-prone and zoning them according to risk magnitudes.

Remote Sensing

Remote sensing is an investigative technique that uses a recording instrument or device to measure or acquire information on a distant object or phenomenon with which it is not in physical or intimate contact.

Potential Applications of Remote Sensing in DMM

- Remote sensing technology is a powerful tool in disaster preparedness, monitoring, relief, and mitigation. Many types of disasters, such as floods, droughts, cyclones, and volcanic eruptions, have certain precursors that satellites can detect.

Potential applications of remote sensing in disaster management include the following:

- Using remote sensing data, such as satellite imageries and aerial photos, variations in terrain properties, such as vegetation, water, and geology, both in space and time can be mapped.
- Satellite images give a synoptic overview and provide practical environmental information, spanning a wide range of scales, from an area of a few metres to entire continents.
- Helps to locate the area of a natural disaster and monitor its growing proportions while the forces of disaster are in full swing, provides information on the disaster rapidly and reliably, and thereby ensuring that the extent of devastation is evaluated precisely.
- Monitoring the disaster event which provides, in turn, a quantitative base for relief operations.
- Such assessment can be used to map the new scenario and update the database used for the reconstruction of the crisis area, thereby helping to prevent the recurrence of such disasters in the future.
-

Disaster	Prevention	Preparedness (Warning)	Relief
Earthquakes	Mapping geological lineaments and land use maps	Geo-dynamic measurements of strain accumulation	Locate stricken areas, map damage
Volcanic eruptions	Topographic and land use maps	Detection/measurement of gaseous emissions	Mapping lava flows, *ashfalls* and lahars, *map damage*
Landslides	Topographic and land use maps	Rainfall, slope stability	Mapping slide area
Flash floods	Land use maps	Local rainfall measurements	Map flood damage
Major floods	Flood plain maps; land use maps	Regional rainfall; evapo-transpiration	Map extent of floods
Storm surge	Land use and land cover maps	Sea state; ocean surface wind velocities	Map extent of damage
Hurricanes		Synoptic weather forecasts	Map extent of damage
Tornadoes		Local weather; local weather observations	Map amount, extent of damage
Drought		Long-range climate models	Monitoring vegetative biomass

Introduction to the basics elements in RS

- ❑ The object to be observed
- ❑ The instrument or sensors to observe
- ❑ The target
- ❑ The form of the 'information' obtained from remote sensing, and the method of storage
- ❑ A platform to hold the instrument

The Sensors

A sensor is a device used to acquire a photograph or an image. What a sensor will do is, it will 'sense' and measure the amount of radiated energy reflected from an object and record it.

- ✓ Although the camera is a type of sensor, the word 'sensor' is normally used for the device used to acquire images in remote sensing.
- ✓ In satellite remote sensing, the types of sensors used of capturing radiation from many different parts of the electromagnetic spectrum, which are visible to the human eye.
- ✓ Active sensors use their own source of energy. Earth surface is illuminated through energy emitted by its own source, a part of its reflected by the surface in the direction of the sensor is received to gather the information.
- ✓ Passive sensors receive solar electromagnetic energy reflected from the surface or energy emitted by the surface itself. These sensors do not have their own source of energy and cannot be used at night time, except thermal sensors. Again, sensors (active or passive) could either be imaging, like camera, or Sensor which acquire images of the area and non-imaging types like non-scanning radiometer or atmospheric sounders.

Data Acquisition

Basic components of an ideal RS system

Uniform energy source: This source would provide energy over all wavelength at a constant, known, high level of output irrespective of time and place.

A non-interfering atmosphere: This would be an atmosphere that would not modify the energy from the source in any manner, whether that energy were on its way to the earth's surface or coming from it. Again, ideally, this would irrespective of wavelength, time, place and sensing altitude involved.

A series of unique energy- matter interactions at the earth's surface: These interactions would generate reflected or emitted signals that not only are selective with respect to wavelength, but also are known, invariant and unique to each and every earth surface feature type and subtype of interest.

A super sensor: This would be a sensor, highly sensitive to all wavelengths, yielding spatially detailed data on the absolute brightness form a scene as a function of wavelength throughout the spectrum. This super sensor would be simple and reliable. Require virtually no power or space and be accurate and economical to operate.

A real-time data processing and supply system: In this system, the instant the radiance wavelength response over a terrain element was generated, it would be transmitted to the ground, geometrically and radio metrically corrected as necessary and processed in to a readily interpretable format. Each data observation would be recognized as being unique to the particular terrain element form which came. This processing would be performed nearly instantaneously (real time) providing timely information.

Multiple data users: These people would have knowledge of great depth both of their respective disciplines and of remote sensing data acquisition and analysis techniques. The same set of data would become various forms of information for different users, because of their wealth of knowledge about the particular earth resources being sensed. This information would be available to them faster, at less expense and over larger areas than information collected in any other manner, wise decision about how best to manage the earth resources under scrutiny and theses management decisions would be implemented.

Interpretation and Analysis - The processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.
Application - The final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem.

These elements comprise the remote sensing process from beginning to end.

Resolution
Resolution is defined as the ability of the system to render the information at the smallest discretely separable quantity in terms of distance (spatial), wavelength band of EMR (spectral), time (temporal) and/or radiation quantity (radiometric).

Resolution types:
Spatial resolution
Spectral Resolution
Radiometric Resolution
Temporal Resolution

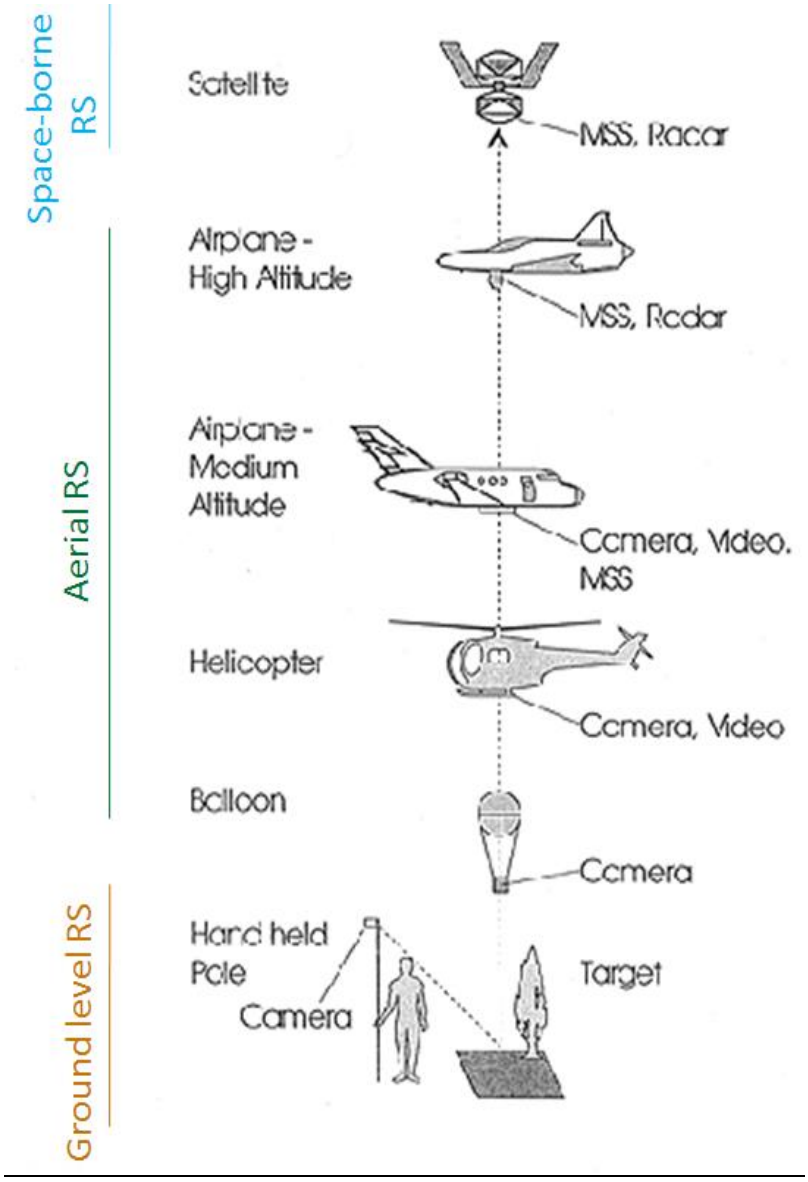
- Spatial resolution— the area on the earth's surface that can be seen by a sensor as being separate from its surroundings and is represented by a pixel.
- It is the projection of a detector element or a slit onto the ground. In other words scanners spatial resolution is the ground segment sensed at any instant. It is also called ground resolution element (GRE).
- The spatial resolution at which data are acquired has two effects –the ability to identify various features and quantify their extent.
- Spectral Resolution – the range of wavelength that satellite imaging system can detect, it refers to the width and number of spectral bands. The narrow band the greater spectral resolution.
  Describes the ability of the sensor to define fine wavelength intervals i.e. sampling the spatially segmented image in different spectral intervals, thereby allowing the spectral irradiance of the image to be determined.

- Radiometric Resolution- is a measure of the sensor to differentiate the smallest change in the spectral reflectance/remittance between various targets. The radiometric resolution depends on the saturation radiance and the number of quantization levels. Thus, a sensor whose saturation is set at 100%, reflectance with an 8 bit resolution will have a poor radiometric sensitivity compared to a sensor whose saturation radiance is set at 20% reflectance and 7 bit digitization.

- Temporal Resolution- is obtaining spatial and spectral data at certain time intervals. Temporal resolution is the capability of the satellite to image the exact same area at the same viewing angle at different periods of time. The temporal resolution of a sensor depends on a variety of factors, including the satellite/sensor capabilities, the swath overlap and latitude.

Remote Sensing Platforms

- Ground level remote sensing
  - Very close to the ground (e.g., Hand held camera)
  - Used to develop and calibrate sensors for different features on the Earth's surface
- Aerial remote sensing
  - Low altitude aerial remote sensing
  - High altitude aerial remote sensing
- Space-borne remote sensing
  - Space shuttles
  - Polar orbiting satellites
  - Geo-stationary satellites



Multi Approach

Ground truth activities are an integral part of the "Multi" approach:

- Multistage: Data should be procured whenever possible from different platforms
- Multilevel : Data collected at various distances from Earth's surface.
- Multispectral : Data collected over various regions of the spectrum.
- Multi temporal :Data obtained at different times.
- Multi phase: some data correlate with one another and also with other remote sensing data.

Remote Sensing in India

The four organizations are engaged in remote sensing related activities besides several other central and state government and educational institutes:-

Indian Space Research Organisation, was formed in 1969. Vikram Sarabhai, having identified the role and importance of space technology in a Nation's development, provided ISRO the necessary direction to function as an agent of development.

It has become one of the six largest space agencies in the world. ISRO maintains one of the largest fleet of communication satellites (INSAT) and remote sensing (IRS) satellites, that cater to the ever growing demand for fast and reliable communication and earth observation respectively.

ISRO develops and delivers application specific satellite products and tools to the Nation: broadcasts, communications, weather forecasts, disaster management tools, Geographic Information Systems, cartography, navigation, telemedicine, dedicated distance education satellites being some of them.

- Apart from technological capability, ISRO has also contributed to science and science education in the country. Various dedicated research centres and autonomous institutions for remote sensing, astronomy and astrophysics, atmospheric sciences and space sciences in general function under the aegis of Department of Space.
- ISRO is moving forward with the development of heavy lift launchers, human spaceflight projects, reusable launch vehicles, semi-cryogenic engines, single and two stage to orbit (SSTO and TSTO) vehicles, development and use of composite materials for space applications etc.

Space Applications Centre (SAC) is a unique centre of ISRO, dealing with a wide variety of themes from satellite payload developments to societal applications. The Centre has its origin in the establishment of the Experimental Satellite Communication Earth Station (ESCES), in 1966 by late Dr Vikram Sarabhai in Ahmedabad.

The centre is responsible for the development, realization and qualification of communication, navigation, earth observation and planetary payloads and related data processing and ground systems in the areas of communications, broadcasting, remote sensing, disaster monitoring/mitigation, etc.

- SAC focuses on the design of space-borne instruments for ISRO missions and development and operationalisation of applications of space technology for societal benefits.

- The applications cover communication, broadcasting, navigation, disaster monitoring, meteorology, oceanography, environment monitoring and natural resources survey.
- SAC designs and develops all the transponders for the INSAT and GSAT series of communication satellites and the optical and microwave sensors for IRS series of remote sensing satellites. Further, SAC develops the ground transmit/receive systems (earth stations/ground terminals) and data/image processing systems.

- **National Natural Resources Management System (NNRMS)** is a national level inter-agency system for integrated natural resources management in the country. NNRMS is established in 1983 and is supported by Planning Commission, Government of India.
- NNRMS supports the optimal utilization of country's natural resources by providing for a proper and systematic inventory of natural resources available using remote sensing data in conjunction with conventional data/techniques.
- In doing so, NNRMS adopts various advanced technologies of satellite and aerial remote sensing; Geographical Information Systems (GIS); precise Positioning Systems; database and networking infrastructure and advanced ground-based survey techniques.
- The major activities of NNRMS include determining user/application needs for remote sensing; conceptualization and implementing remote sensing space segments with necessary ground-based data reception, processing and interpretation facilities; establishing utilization systems for using remote sensing images and conventional data for various applications and resource management activities.

- **National Remote Sensing Agency (NRSA)** was established 2nd September 1974 by Department of Science & Technology. The objective of organisation being undertaking and facilitating remote sensing activities in the country.
- NRSA was transferred from DST to new created Department of Space in 1980 as an autonomous centre. Indian Photo-interpretation Institute was renamed as Indian Institute of Remote Sensing in 1983. On 1st November 1995, the UN affliliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTE-AP) was created and hosted at Indian Institute of Remote Sensing (IIRS), Dehradun. On September 1, 2008 NRSA was converted from a autonomous organisation to a fully Government organisation under ISRO and renamed National Remote Sensing Centre (NRSC).

- IIRS was made as independent unit under Management Council on April 30, 2011 and thus ceased to be a part of NRSC. During December, 2009 Regional

Remote Sensing Service Centres located at Dehradun, Kolkata, Jodhpur, Nagpur and Bengaluru were amalgamated with NRSC and renamed as Regional Remote Sensing Centres. Regional Remote Sensing Centre, Dehradun was merged with Indian Institute of Remote Sensing (IIRS), Dehradun by November 1, 2011.

General methods for disaster management

- Risk assessment is a complex process aiming at evaluating the different aspects that can disrupt or destruct a system, providing means for understanding the causes and consequences of those risks.
- Traditionally, risk assessment relies on mathematical models to establish the likelihood of a given event occurring with a given degree of intensity in a given site.
- The major limitation of this type of approach is that risk necessarily entails uncertainty and it is necessary to make realistic hypotheses about possible future scenarios.
- For complex systems, such as critical infrastructures, the understanding of all factors involved in a risk situation is particularly demanding.
- Therefore, risk assessment approaches require to take into account all relevant social, economic, cultural, and political aspects, in order to define the vulnerability, resilience and capacity of response of a territorial system to different threats.

  A fundamental principal of risk assessment is that natural or industrial hazards are location dependent, and that generally reliable historical and location specific data are available – e.g. regarding failures, potential damages, etc.
- Many of the decisions we make every day involve being able to access, understand and utilize the space around us.
- This type of information is referred to as spatial information, and by visualizing, we can see relationships, patterns, and trends that may not otherwise be apparent.

<u>Need of GIS in risk assessment</u>

- There is a critical need for consistent standards to avoid fragmentation of information.
- Consistent data consolidation over many years helps transform data into knowledge.
- Various types of information relating to organizations' risk exposures become accessible and manageable from individual desktop computers.

- GIS proves an important aid for risk management. Gathering data to create a GIS to meet potential emergencies requires an immediate and concentrated effort.

- It is far easier to accomplish this task before an attack or emergency than in its aftermath.
- GIS can deliver not only data on hazards in the region information on building, lifelines, and critical facilities, but can also contain built in risk assessment programmes that allow the planner to simulate disaster scenarios and graphically view the potential damages and affected areas as well as plan rescue operations.

GIS for earthquake hazard

- Mapping of active faults
- Measurement of fault displacement
- Post-earthquake damage assessment

There are two methods:

1. A simple method, followed by the RADIUS methodology, in which Peak Ground Acceleration is calculated for a scenario earthquake, and the amplification of soil is treated by simple multiplication values. This method gives only a very general approximation of the hazard
2. A second method in which the earthquake spectra is considered, and the natural frequency of the soil is calculated, which is used to delineate areas which will experience large ground amplifications at specific frequencies which correspond to natural frequencies of certain building types.

Flood Management

- In the similar way as in other disasters the various geospatial data can be used as input layers to analyze the following:
    - Flood inundation mapping and monitoring
    - Rapid and scientific based damage assessment
    - Monitoring and mapping of flood control works and changes in river course
    - Identification of river bank erosion
    - Identification of chronic flood areas
    - Inputs for flood forecasting and warning models

GIS in epidemiological studies

- The branch of medicine that deals with the incidence, distribution, and control of diseases.
- The GIS establishes spatial relations between a disease and other information (the distance of the possible pollution sources, the presence of cluster...), through the geocoding
- GIS tools important for epidemiology are the overlay process and the buffer calculation.

- Geospatial Data Requirement:
    - Drainage layer showing open outlets
    - Ponds and other water bodies
    - Administrative boundaries with slum areas.
    - Water Tanks and Water Distribution Networks with enough attribute information on purification process etc.
    - Movement of infectious animal carrier
    - Settlement Area
    - Forest Area.

- Identify the prime factors that may cause outbreak of any types of disease from the above mentioned layers.
- Overlay all the geospatial layers for over lay analysis.
- The resultant polygons will be so many in numbers and each of these polygons will have attribute information from all the input layers.
- Any of the statistical method or more then method can be used to study the probability of outbreak of any kind of epidemics in each of the polygons.
- A suitable algorithm can be designed to calculate the probability information for all the polygons in one go.
- Based on the probability Information Value the whole of the study area be segregated in high, medium and low probability zones.
- The polygons with more then 50% probability of occurrence can be segregated for taking special precautionary action.
- If at all an epidemic out breaks in the given area, the point location of out break is immediately entered in the GIS.
- Then a buffering is created around the point to make as assessment of the nearby areas which are vulnerable to epidemic.
- The Geo-Informatics tools will be helpful in monitoring both the pre and post epidemic scenario very effectively.

Tsunami

- Geospatial Data Requirement:
    - Administrative boundaries up to the sea shore.
    - All important point locations with in the boundaries.
    - Point Locations of disaster management control rooms, police stations, administrative offices etc. with sufficient information about each of them in the attribute table.
    - The occurrence of tsunami is informed to the Disaster Management Control Room either by an automated machine placed at the sea shore, any citizen or government servant.

- On the basis of the received information about the place of occurrence the control room GIS operator will prepare an estimated effected area map immediately.
- At the same time an alert will be sent to all disaster management authorities within and in the nearby area who will then rush to the effected area with the GPS and devices for communication.
- The team will then keep on informing all the details to the GIS enabled control room where based on the received information following details will be prepared and communicated to all the concerned authorities.
- villages that are effected by the tsunami
- the number of houses, public properties and the population that are effected by the tsunami.
- The amount of loss vis-à-vis the estimate of rehabilitation teams, medicines, food grains to be arranged
- subsequently the budget requirement can be almost accurately made sitting at the desktop.
- Similarly GIS can also be used for
- Monitoring of the rehabilitation progress
- Providing inputs for further action.
- Preparing reports on the ongoing work with respect to percentage of coverage and completion.
- Monitoring of the epidemic due to tsunami

Fire Hazard

- Geospatial Data required for rural areas:
- smallest administrative boundaries, transportation network layers, settlement layers, forest layers, land cover layers and population centers, point of water tanks location
- For urban Areas:

spacio-temporal traffic information, fire brigade locations in addition to the above.

- Satellite Images or the aerial photographs of the area.
- These data should be ready at the GIS enabled fire brigade control room.
- The occurrence of the fire accident is reported to the control room by traffic police or any citizen using any mode of communication giving the exact location like place name, street no., house no. etc.
- Based on the received information, a point event of occurrence of accident is created in GIS.

- Distance of the point from all the near by fire brigade offices with fire vans and the **source of abundant water** will be calculated with in a second and listed by the GIS.

- Based on the time of the accident the shortest and suitable route to the point will be suggested by the GIS.
- In a networked GIS the software can be customized to send automatic alert of the information to all concerned authorities.
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- In a networked GIS the software can be customized to send automatic alert of the information to all concerned authorities.

Cyclone

- Similarly the geo-informatics tools and the geospatial data can be effectively used in cyclone management specially for :
    - Collation and compilation of spatio-temporal weather information for weather monitoring
    - Cyclone mapping and risk assessment.
    - Cyclone forecasting and preparation of warning models

Accidents handling

- Road Accidents & Train Accident :
    - Mapping of the accident spot in GIS
    - Calculation of distance to the nearest settlement area, NGO offices, police stations, schools and hostels from where first rescue teams can be requested for.
    - Calculation of distance to the nearest hospitals and working out the shortest and traffic free route to the hospitals.
    - Detail mapping of the accident area in case of loss of bodies, belongings and valuables.

Unit V

Risk and vulnerability to disasters

Role of different organizations for DMM in India

- The first initiative towards formulating a systematic, comprehensive and holistic approach to all disasters, was the setting up of a High Powered Committee (HPC) in August 1999 under the Chairmanship of Shri J.C. Pant.
- The HPC prepared comprehensive model plans for DM at the national, state and district levels.
- An all party National Committee on Disaster Management (NCDM) was set up after the Gujarat earthquake, under the Chairmanship of the Prime Minister and with representatives of national and state level political parties, for catalysing and enabling the preparation of DM plans and suggesting effective mitigation mechanisms.
- On 23 December 2005, the Government of India took a defining step towards holistic DM by enacting the DM ACT, 2005.

The Disaster Management Act, 2005

- DM Act covers all aspects from prevention, mitigation, preparedness to rehabilitation, reconstruction and recovery.
- It also mandates the NDMA to lay down policies and guidelines for the statutory authorities to draw their plans.

It also provides for:

- The creation of a policy, legal and institutional framework, backed by effective statutory and financial support.
- The mainstreaming of multi-sectoral DM concerns into the developmental process and mitigation measures through projects.
- A continuous and integrated process of planning, organising, coordinating and implementing policies and plans in a holistic, community based participatory, inclusive and sustainable manner.

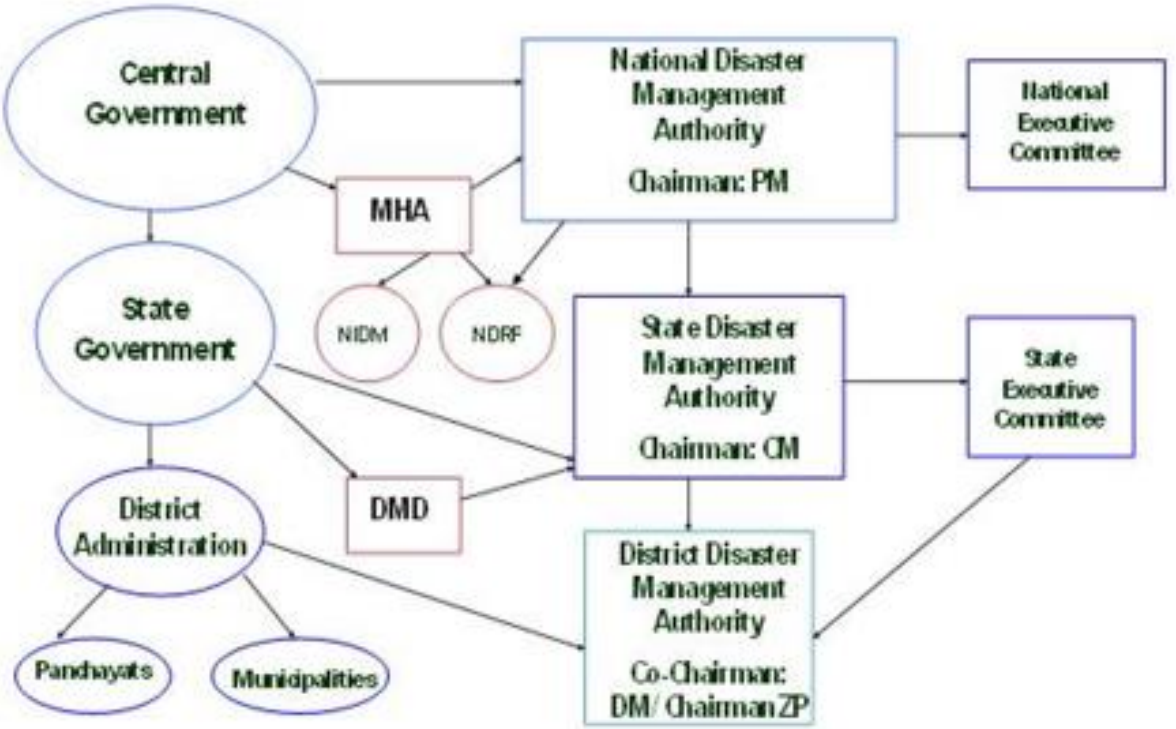
- It provides for the establishment of NDMA, SDMA and DDMA at the National, State and District levels
- It provides with adequate financial and administrative powers and creation of the National Institute of Disaster Management (NIDM).
- The act also provides for establishment of National Disaster Response Force (NDRF).
- It mandates

- undertaking training and capacity building
- Develop Training Modules on various aspects of Disaster management
- Undertake Research and Documentation
- Formulate and implement comprehensive HRD Plan covering all aspects of DM
- Provide assistance in national level policy formulation and
- Provide assistance to state governments and State Training Institutions.

The act also provides guidelines for-

- Creation of National Disaster Response Fund
- National Mitigation Fund
- Establishment of funds by State Government

Allocation of funds by Ministries and Departments for Emergency procurement



- The Central Government lays down policies and guidelines and provides technical, financial and logistic support.
- The district administration carries out most of the operations in collaboration with central and state level agencies.

- The Disaster Management Act, 2005 has created new institutions at the national, state, district and local levels. The new institutional framework for disaster management in the country is as under:

- **The Cabinet Committee on Management of Natural Calamities (CCMNC)** oversees all aspects relating to the management of natural calamities including assessment of the situation and identification of measures and programmes necessary to reduce its impact, monitor and suggest long term measures for prevention of such calamities, formulate and recommend programmes for public awareness for building up society's resilience to them.

- **The Cabinet Committee on Security (CCS)** deals with the matters relating to nuclear, biological and chemical emergencies.

- **The National Crisis Management Committee (NCMC)** under the Cabinet Secretary oversees the Command, Control and Coordination of the disaster response.

Ministry of Home Affairs (MHA)

- The Ministry of Home Affairs (MHA) in the Central Government has the overall responsibility for disaster management in the country.
- For a few specific types of disasters the concerned Ministries have the nodal responsibilities for management of the disasters, as under:
- Drought - Ministry of Agriculture
- Epidemics & Biological Disasters - Ministry of Health and Family Welfare
- Chemical Disasters - Ministry of Environment & Forests
- Nuclear Disasters - Ministry of Atomic Energy
- Air Accidents - Ministry of Civil Aviation
- Railway Accidents - Ministry of Railways

National disaster management authority (NDMA)

- An agency of the Ministry of Home Affairs
- It was established through the disaster management act enacted by the GOI in Dec 2005
- To co-ordinate response to natural or man made disasters
- Responsible for framing policies, laying down guidelines and best practices and co-ordinating with the SDMA's to ensure a holistic and distributed approach to disaster management.

Role of NDMA

- The NDMA will concentrate on prevention, mitigation, preparedness, and rehabilitation and reconstruction phases.
- It also formulates appropriate policies and guidelines for effective and synergised national disaster response and relief.
- It will coordinate the enforcement and implementation of policies and plans.

- The National Disaster Management Authority (NDMA) under the Chairmanship of the Prime Minister is the apex body responsible for laying down policies, plans and guidelines for disaster management and for coordinating their enforcement and implementation throughout the country.
- These policies and guidelines will assist the Central Ministries, State Governments and district administration to formulate their respective plans and programmes.
- NDMA has the power to approve the National Plans and the Plans of the respective Ministries and Departments of Government of India.
- It also directs and controls National Disaster Response Force (NDRF).

Role of National Executive Committee

- The National Executive Committee (NEC) is responsible to prepare the National Plan and coordinate and monitor the implementation of the National Policy and the guidelines issued by NDMA.

  The NEC comprises of –
- The Union Home Secretary as the Chairperson
- The Secretaries to the GOI in the Ministries/Departments of Agriculture, Atomic Energy, Defence, Drinking Water Supply, Environment and Forests, Finance, Health, Power, Rural Development, Science and Technology, Space, Telecommunications, Urban Development, Water Resources and the Chief of the Integrated Defence Staff as members.
- Special invitees to the meetings of the NEC are- Secretaries in the Ministry of External Affairs, Earth Sciences, Human Resource Development, Mines, Shipping, Road Transport & Highways and Secretary, NDMA.

The Role of SDMA/SEC & the State Departments

- Section 23 of the DM Act 2005 provides that there shall be a DM plan for every state.
- It outlines the broad coverage of the plan as well as the requirements of consultation in the preparation of the state plans.
- It also provides for annual review and updating of the state plan, and enjoins upon the state governments to make provisions for financing the activities to be carried out under the state plans.
- It provides for the departments of the state governments to draw up their own plans in accordance with the state plan.

- The state plans shall be prepared by the SEC in conformity with the guidelines to be issued on related matters by the SDMA. The state plan prepared by SEC shall be approved by the SDMA.

National Institute of disaster Management

- The National Institute of Disaster Management has the mandate for human resource development and capacity building for disaster management within the broad policies and guidelines laid down by the NDMA.

NIDM is required to-

- design, develop and implement training programmes,
- undertake research, formulate and
- implement a comprehensive human resource development plan,
- provide assistance in national policy formulation,
- assist other research and training institutes, state governments and other organizations for successfully discharging their responsibilities,
- develop educational materials for dissemination and
- promote awareness among stakeholders

State Disaster Management Authority

- At the State Level the State Disaster Management Authority (SDMA), headed by the Chief Minister, lays down policies and plans for disaster management in the State.
- It is also responsible to coordinate the implementation of the State Plan, recommend provision of funds for mitigation and preparedness measures and review the developmental plans of the different departments of the State to ensure integration of prevention, preparedness and mitigation measures.
- The State Disaster Management Department (DMD) which is mostly positioned in the Revenue and relief Department is the nodal authority.

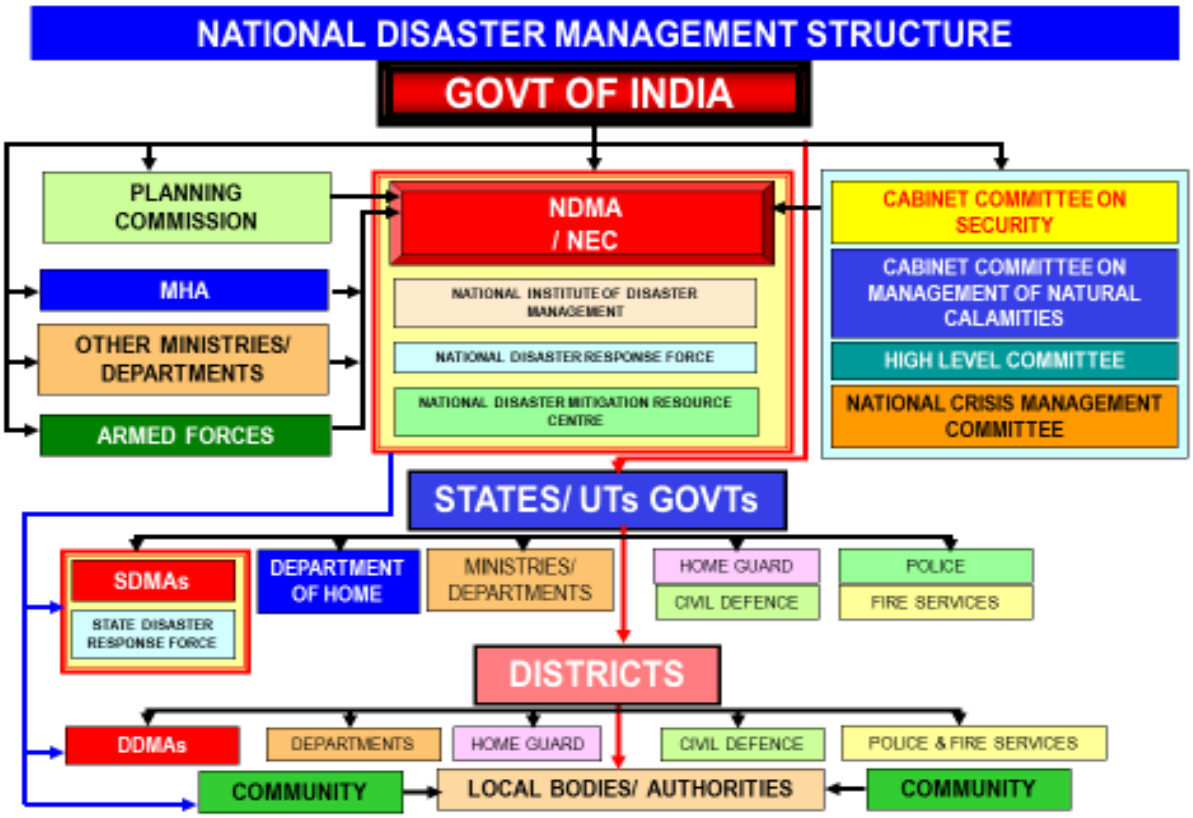
District Disaster Management Authority

- In the district level the District Disaster Management Authority (DDMA) is headed by the District Magistrate, with the elected representative of the local authority as the Co-Chairperson.
- DDMA is the planning, coordinating and implementing body for disaster management at district level.
- It will prepare the District Disaster Management Plan and monitor the implementation of the National and State Policies and the National, State and the District Plans.
- DDMA will also ensure that the guidelines for prevention, mitigation, preparedness and response measures laid down by the NDMA and the

SDMA are followed by all departments of the State Government at the district level and the local authorities in the district.

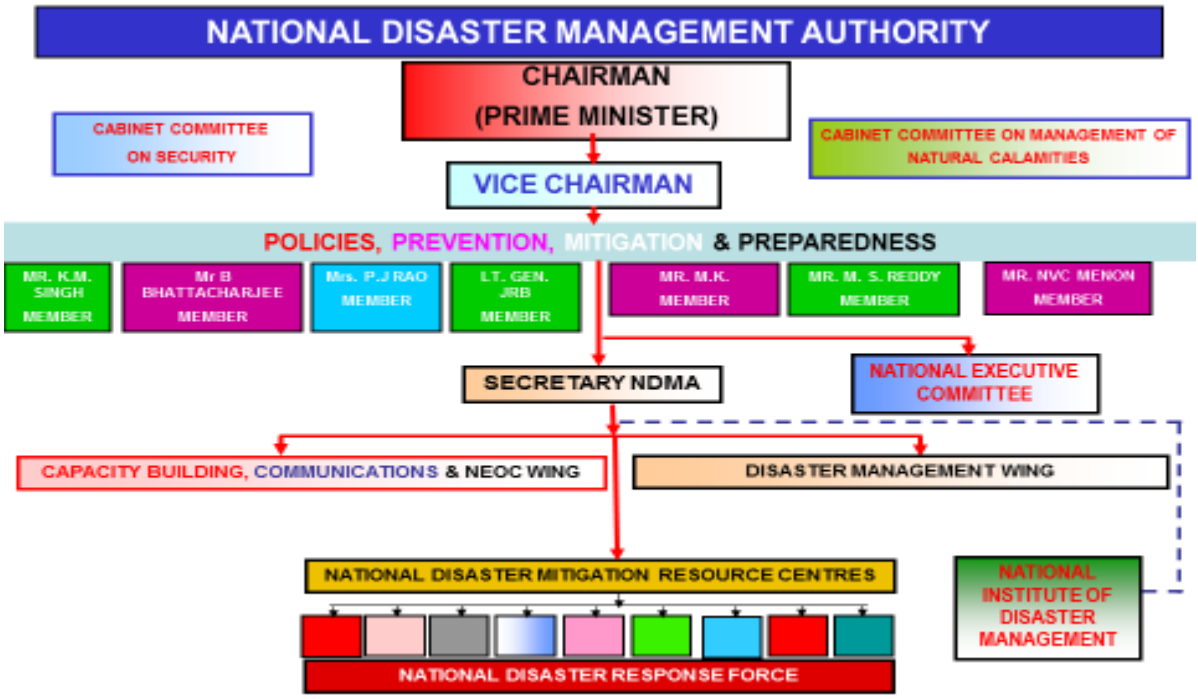
Strategies for disaster management

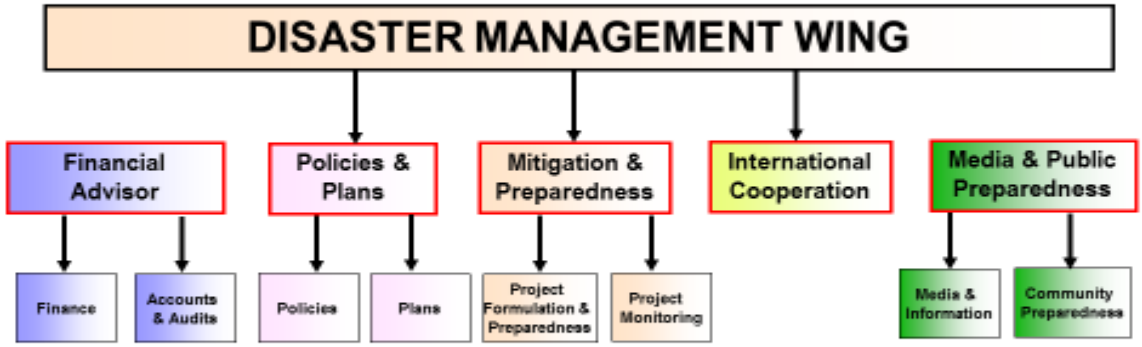
- Change of Focus from Relief Centric to Holistic Approach.
- Mainstreaming Disaster Management into all National Developmental Programmes.
- Empowerment of the Community to face the Disaster.
- Emphasis on Training, Development of Human Capital and Capacity Building.
- Key Role of Educational and Professional Institutions for Mass Education and Awareness.
- Upgradation of the Key Responders.
- Supporting and Enabling Mechanisms for the Districts and States.
- Failsafe Early Warning & Communication Systems.
- Coordinated, Timely and Effective Response.
- Involvement of NGOs & Corporate Sectors.
- Time Bound Action Plan for Earthquakes, Floods & Cyclones.
- Pro-active Participation at the Regional and International Level.

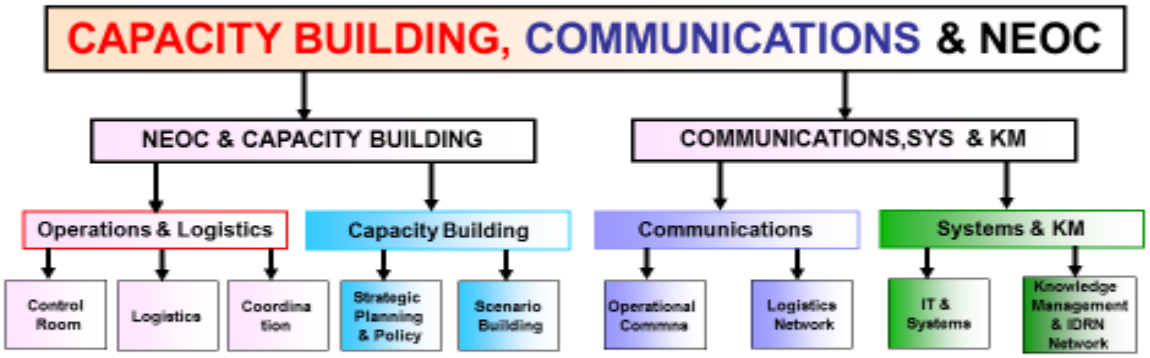


1. The 'National Authority' shall have the responsibility for laying down Policies, Plans and Guidelines for Disaster Management for ensuring timely and Effective Response to disasters (Both Natural & Man Made).
2. Coordinate the Enforcement and Implementation of the Policy and Plans for Disaster Management.
3. International Assistance and Cooperation.

The organization



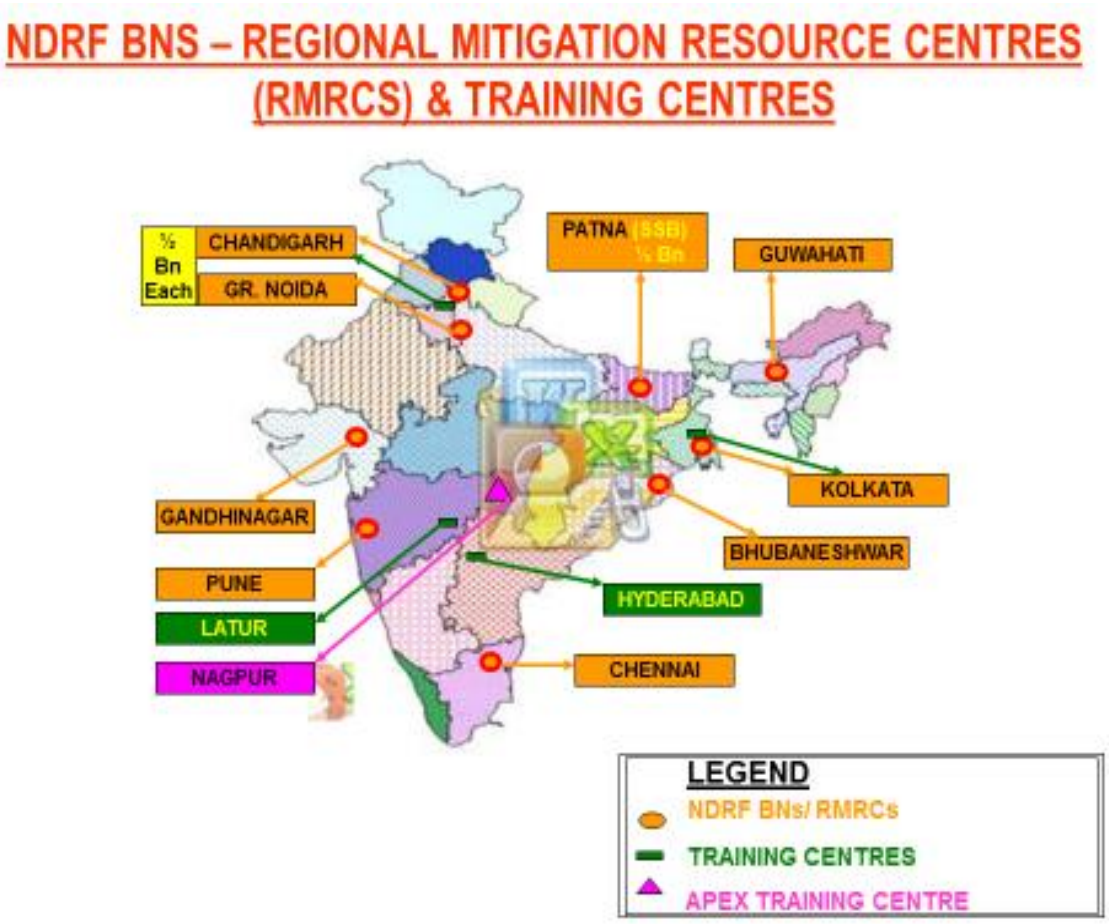




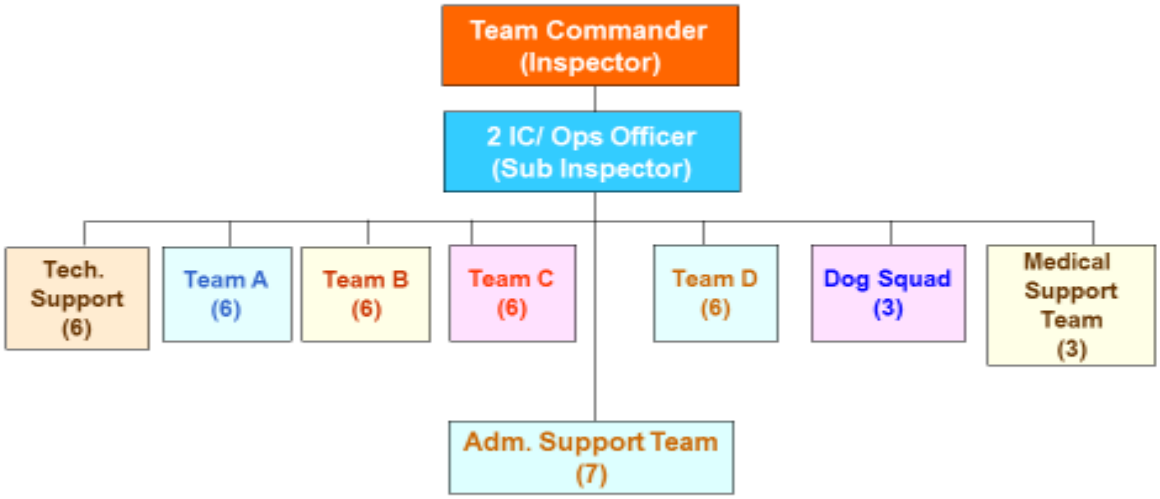
NATIONAL DISASTER RESPONSE FORCE

- NDRF consists of 8 battalions, with 144 self-sustaining teams for rendering effective response to any threatening disaster situation or disaster.
- Four battalions are for natural disasters and four for NBC.
- NBC battalions will also be trained in combating natural disasters.
- The force will be equipped with State of the Art equipment and will be deployed in anticipatory manner to provide instantaneous response.

- It will work under NDMA and will be located at nine vulnerable locations.
- They will maintain close liaison with the State Governments and will be available to them automatically, thus, avoiding long procedural delays.
- Four Training Centres have been set up by PMF to train their respective NDRF Battalions.
- They will also meet the requirement of States/ UTs.
- NDRF Battalions will impart basic training to State Disaster Response Force in their respective locations.

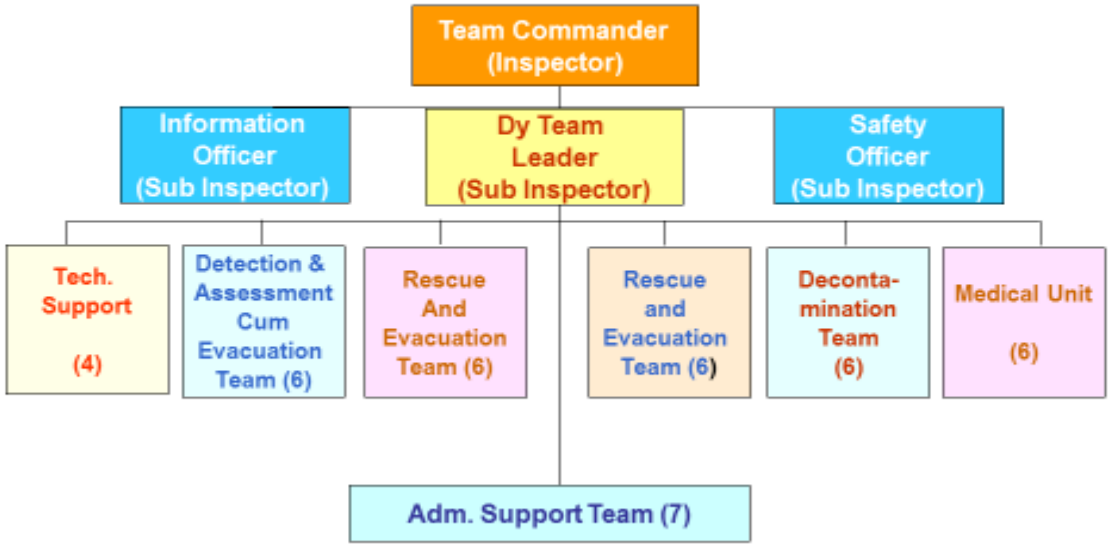


CONSTITUTION OF SPECIALISED SEARCH AND RESCUE TEAM



Total – 45 Personnel

CONSTITUTION OF SEARCH AND RESCUE TEAM FOR NBC EMERGENCIES



Total – 45 Personnel

Policy formulation team composition
Concerned Member of Authority.
Concerned Ministry – Representative.
Lead/Nodal Organisations/Departments- Representatives
Project Team
Advisors/Experts
Leading National (Academic – IITs) Institutions.
Secretarial Support
Additional Secretary.
Joint Secretary Planning.
DDG Strategic Planning.

Levels of disaster

- The approach to the preparation of the state DM plan should be holistic and address all the hazards the state is vulnerable to.
- It should take into account past lessons and experiences, build on good existing systems at different levels.
- The levels of disasters have already been categorised and disseminated as L0, L1, L2 and L3, based on the ability of various authorities to deal with them.
- L0: denotes normal times which are expected to be utilised for close monitoring, documentation, prevention, mitigation and preparatory activities.
- This is the planning stage where plans at all levels from community to the State shall be put in place.
- Training on search and rescue, rehearsals, evaluation and inventory updation for response activities will be carried out during this time.
- L1: specifies disasters that can be managed at the district level, however, the state and centre will remain in readiness to provide assistance if needed.
- L2: specifies disaster situations that may require assistance and active participation of the state, and the mobilisation of resources at the state level.
- L3: disaster situations arise from large scale disasters where districts and the state may not have the capacity to respond adequately and require assistance from the central government for reinstating the state and district machinery.

Objectives of Disaster Management plan

- The aim of the state DM plan is to ensure that the following components of DM are addressed to facilitate planning, preparedness, operational, coordination and community participation.
- The objectives guiding the policy formulation are:
- Promoting a culture of prevention and preparedness by ensuring that DM receives the highest priority at all levels.
- Ensuring that community is the most important stakeholder in the DM process.

- Encouraging mitigation measures based on state-of-the-art technology and
- environmental sustainability.
- Mainstreaming DM concerns into the developmental planning process.
- Putting in place a streamlined and institutional techno-legal framework for the creation of an enabling regulatory environment and a compliance regime.
- Developing contemporary forecasting and early warning systems backed by responsive and fail-safe communications and Information Technology (IT) support.
- Promoting a productive partnership with the media to create awareness and contributing towards capacity development.
- Ensuring efficient response and relief with a caring approach towards the needs of the vulnerable sections of the society.
- Undertaking reconstruction as an opportunity to build disaster resilient structures and habitat.
- Undertaking recovery to bring back the community to a better and safer level than the pre-disaster stage.

Key Responsibilities of Agencies

- Planning: development of strategies and requirement analysis for resource utilisation.
- The establishment of structures, development of systems and testing and evaluation by organisations of their capacity to perform as per allotted roles.
- Coordinated Execution of Plans: Increased coordination, convergence and synergy among the departments and institutions should be promoted in order to promote sharing of resources, perspectives, information and expertise through support of training centres, academic and applied research, education and awareness generation programme, etc.
- Mainstreaming DM Concerns into Development Programmes: This deals with integration of measures for prevention of disasters and mitigation into developmental plans and projects including mitigation projects and to facilitate provision of adequate funds for DM. Plans may be shown in three broad categories, viz. short, medium and long term.
  The structural and non-structural measures to be taken may be brought out in each category.

Guiding Principles for the Preparation of State Plans

Participatory approach:

The plan preparation process essentially aims at strengthening the communities, elected local bodies and state administration's response and preparedness.

- The plans should be prepared through a participatory approach including identification of vulnerabilities and risks, and also be holistic, inclusive, sustainable and environment friendly.
- The plans should be sensitive to the special needs of vulnerable sections such as Women, children, the elderly and physically and mentally challenged persons.

Community Based approach:

- Community participation ensures local ownership, addresses local needs, and promotes volunteerism and mutual help to prevent and minimise damage.
- Therefore, states should make all efforts to assist communities in understanding their vulnerabilities and the lead role that they can play in managing risks with less dependence on external entities.

The framework of plan

- The framework of the plan should highlight the importance of preparedness, prevention and mitigation which comprises of three parts:
- General issues including broad vulnerability profile of the state. It will also comprise other thematic issues such as community based DM, medical preparedness, awareness generation, training needs analysis and development of a state Human Resources (HR) plan, knowledge management, early warning and forecasting system standards for relief, rehabilitation etc.
- Disaster specific issues and methodologies.
- Cross-cutting issues common to all situations in any disaster. It will specifically deal with implementation, monitoring and review arrangements.

Sections of the Framework

The framework will comprise sections that deal with:

Operational: Take into account the socio-cultural realities of the state, and should be equity based— recognising the differential needs of all sections of the society

- Be in harmony with national, district, block, village and community level plans and should incorporate implementation strategies as well as indicate specific monitoring and evaluation mechanisms.
- Develop a base line and identify the total risk and also agree on the minimum acceptable level of risk
- Include a reference to the components of HRD plan for DM, with specific emphasis on features specifically such as:
  - Training needs analysis.
  - Involvement, besides the Administrative Training Institutes (ATIs), of other sectoral training and educational institutions in the exercise.

  - Contemplated professional training for micro planning, which should adopt the multi-hazard approach and develop inbuilt simulation techniques for the application of the plan.
- Describe the role of the Emergency Operations Centre (EOC)
- Incorporate Medical Preparedness and Mass Casualty Management

Administrative. The plan must be in accordance with the development plans of the state five-year plans. The plan should also be in conformity with the state DM policy.

- The systems and institutions for implementation of the plans must be clearly identified and spelt out.
- The plan should explicitly take note of the available NDRF, Civil Defence, Home Guards, youth and students organisations etc., the National Cadet Corps (NCC), National Service Scheme (NSS) and Nehru Yuva Kendra (NYK) networks.
- Specific plans for capacity building and training should also be included in a separate chapter.
- Public-Private Partnerships will be factored into the DM approach and the modalities through which these will work also need to be incorporated.
- Knowledge Management— Establishment and operation of Community Service Centres (CSCs).
- Measures for documenting the indigenous local practices for DM.
- Regular updation of the resource inventory
- Interface with Panchayati Raj Institutes, NGOs and the community at large and utilising their assistance should be clearly brought out.

Financial:

- Be supported with necessary budget provisions for short, medium and long term activities. The DM Act, 2005 mandates the constitution of a State Disaster Response Fund at the state level and District Disaster Response Funds at the district level.
- Be a component sub-plan of the state's annual and five-year plans, indicating upfront the allocation of each of the departments involved along the lines of the tribal area sub-plan.
- Reflect the provision of adequate funds for the requirements of relief material when disaster strikes, estimated on the basis of past experience. Care should also be taken to make full provision for the requirements of forces deployed on these occasions.

Legal Aspects:

This section will cover aspects such as:

- The responsibility of the SEC:

- To coordinate and monitor the implementation of the national policy, the national plan and the state plan.
- To provide information to the NDMA relating to various parameters of DM.
- To earmark funds for prevention and integration of disasters in their development plans and projects.
- Put in place techno-legal regimes; e.g., amending building bye-laws, bringing in flood plain zoning legislation etc.

Process:

- Designate the nodal department for coordinating formulation of the state plan.
- Identify the focal point in each relevant department; consisting of a core group of officers and provide for adequate training to professionalise their approach.
- Involve administrative/ technical institutions for providing technical support.
- Describe nodal department(s) for involvement of NGOs, CBOs, corporate sector, youth organisations, educational institutions, Panchayati Raj Institutions (PRIs), urban local bodies, media and other stakeholders—and the modalities of such partnerships.
- Outline the logistics management in all aspects of DM from preparedness to recovery.
- Describe the consultative process with local authorities, district authorities and people's representatives

Early Warning Systems

The Hyogo Framework for Action

The Hyogo Framework for Action (ISDR 2005), which was adopted by the World Conference on Disaster Reduction in Hyogo, Japan in 2005, identified five priority areas:

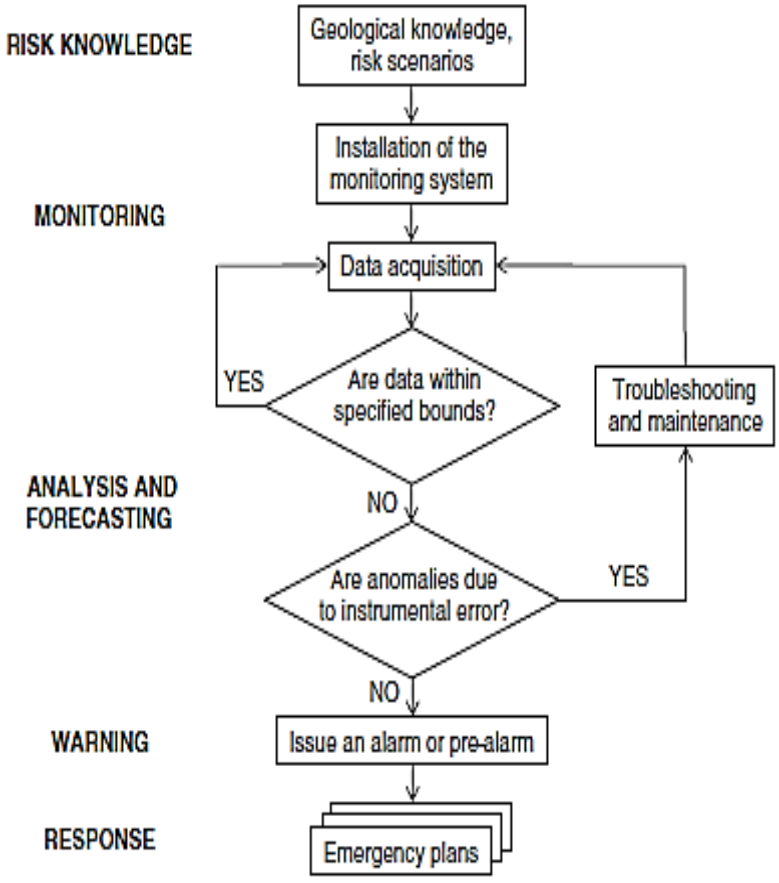
1. Ensure that disaster risk reduction (DRR) is a national and local priority with a strong institution basis for implementation;
2. Identify, assess and monitor disaster risks and enhance early warning;
3. Better knowledge management for building a culture of safety;
4. Reducing the underlying risk factors; and
5. Enhance preparedness for an effective response

Earth Observation

Earth Observation, through measuring and monitoring, provides an insight and understanding into Earth's complex processes and changes. EO include measurements that can be made directly or by sensors in-situ or remotely (i.e. satellite remote sensing, aerial surveys, land or ocean-based monitoring systems) to provide key information to models or other tools to support decision making processes.

Early Warning Systems

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.



Effective Early Warning Systems are intended:

- To extend the lead time of warnings
- To improve the accuracy of warnings
- greater demand for probabilistic forecasts
- better communication and dissemination of warnings using new techniques to alert the public targeting of the warning services to relevant and specific users
- Warning messages are understood and the appropriate action taken in response.

Prerequisites for an E W S

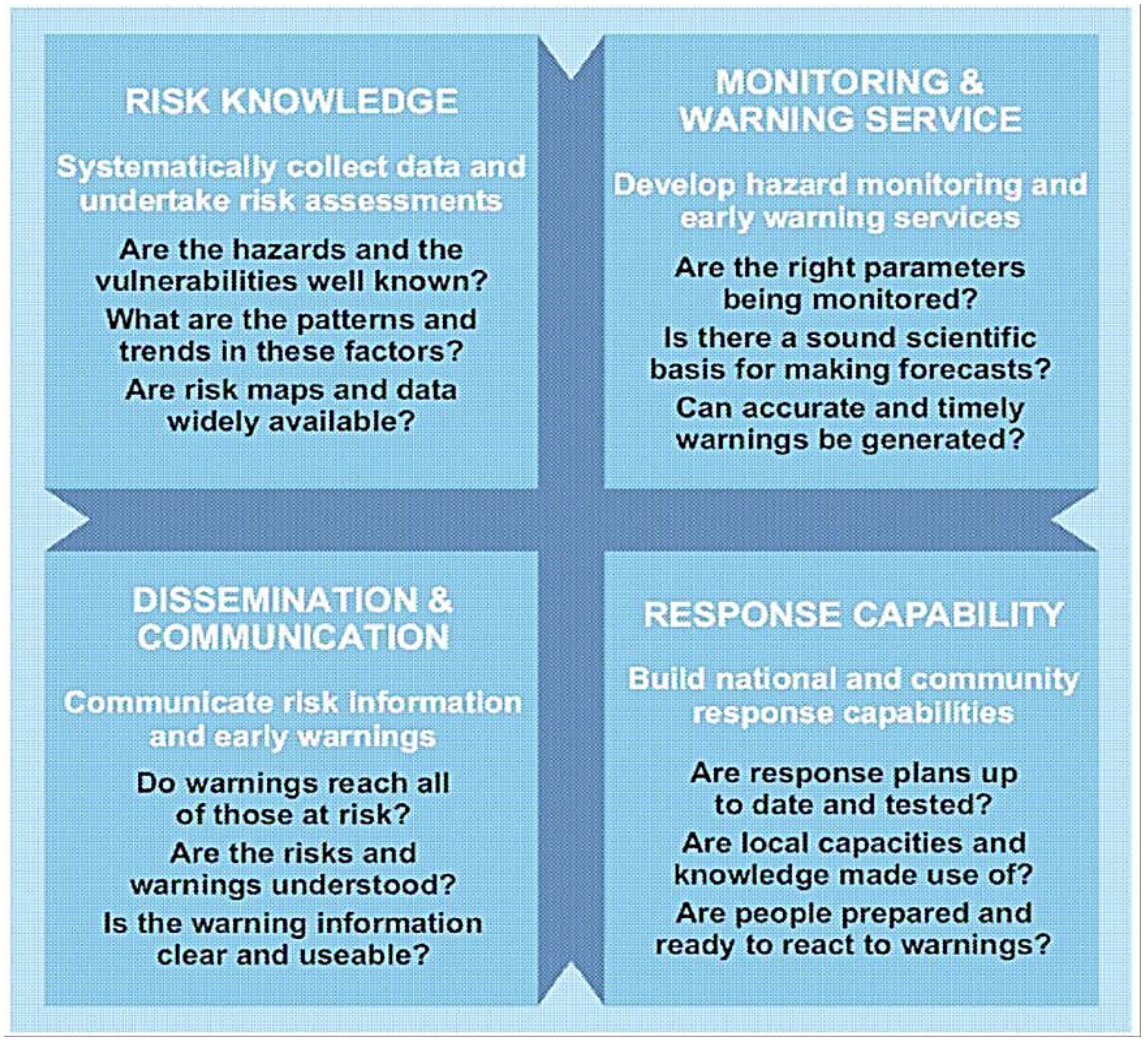
- Focus on the User
- Identify the users
- The hazards community
- Weather-sensitive economic sectors
- Media (print, radio, TV and others)
- The public

Effective Warning Program includes:

- Receive the warning
- Understand the information presented
- Believe the information
- Personalize the information
- Make correct decisions
- Respond in a timely manner

People Centered Early Warning Systems

- Risk Knowledge
- Monitoring and Warning Service
- Dissemination and Communication
- Response Capability


RISK KNOWLEDGE
Systematically collect data and undertake risk assessments
Are the hazards and the vulnerabilities well known?
What are the patterns and trends in these factors?
Are risk maps and data widely available?
MONITORING & WARNING SERVICE
Develop hazard monitoring and early warning services
Are the right parameters being monitored?
Is there a sound scientific basis for making forecasts?
Can accurate and timely warnings be generated?
DISSEMINATION & COMMUNICATION
Communicate risk information and early warnings
Do warnings reach all of those at risk?
Are the risks and warnings understood?
Is the warning information clear and useable?
RESPONSE CAPABILITY
Build national and community response capabilities
Are response plans up to date and tested?
Are local capacities and knowledge made use of?
Are people prepared and ready to react to warnings?