

UNIT-1

INTRODUCTION TO DISASTER

Define disaster

A disaster is a natural or man-made event that negatively affect the life, life, property, livelihood or industry often result in permanent changes to human societies, ecosystem and environment.

(OR)

A disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material and economic or environmental losses that exceeds the community or society's ability to cope using its own resources.

Types of disaster

1. Natural disaster

A disaster caused by natural factors called as natural disasters
Ex. Earthquake, flood, cyclone, drought..etc

2. Man-made disaster

A disaster caused due to the human activities is called man-made disaster
Ex. Wars, fire accidents, industrial accidents..etc

Hazard

It is defined as the process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

(OR)

A hazard is any agent that can cause harm or damage to human property to the environment.

Vulnerability

It refers to the inability to withstand and recover from the impact of a natural or man-made hazard.

Types of vulnerability

1. Physical vulnerability

It is determined by the aspects such as population density levels, remoteness of settlements, site, design and materials used for construction

Ex. Wooden homes are less likely to collapse in an earthquake, but are more vulnerable to fire

2. Social vulnerability

It refers to the inability of people, organizations and societies to withstand adverse impacts to hazards due to characteristics inherent in social interactions, system of cultural values

Ex. When flooding occurs some citizens such as children, elderly and differently-able, may be unable to protect themselves or evacuate if necessary

3. Economic vulnerability

The level of vulnerability is highly dependent upon the economic status of individuals, communities and nations

The poor are usually more vulnerable to disasters because they lack the resources to build structures and put other engineering measures in place to protect themselves from being negatively impacted by disasters

Ex. Poorer families may live in squatter settlements because they cannot afford to live in safer areas

4. Environmental vulnerability

Natural resource depletion and resource degradation are the key aspects of environmental vulnerability

Ex. Deforestation, land, water and air pollution..etc

Factors affecting vulnerability

1. Physical factors

Poor design and construction of buildings, unregulated landuse planning..etc

2. Social factors

Poverty, marginalisation, discrimination by gender, social status, disability and age..etc

3. Economic factors

Vulnerable rural livelihoods, dependence on single industries, globalization of business and supply chains

4. Environmental factors

Poor environmental management, over consumption of natural resources, climate change..etc

Disaster management

It is defined as the organisation and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies in particular preparedness, response, recovery in order to lessen the impact of disaster

Goals of disaster management

- To reduce or avoid potential losses (lives and infrastructure) from hazards
- Assure the prompt and assistance to victims
- Achieve rapid and effective recovery

Disaster resilience

It is the ability of individuals, communities, organisations and state to adapt and recover from hazards, shocks or stresses without compromising long-term prospects for development

Risk or disaster risk

It is the potential loss of life, injury, destroyed or damaged property which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure or a capacity

$$\text{Risk} = \text{hazard} \times \text{exposure} \times \text{capacity}$$

Capacity

The ability of people, organisations and systems, using available skills and resources, to face and manage adverse condition, emergencies or disaster

Exposure

The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas

DISASTERS: TYPES OF DISASTER

EARTHQUAKE

- Earthquake is one of the most devastating natural disaster on earth
- Earthquake effects can cover hundreds to thousands of square kilometers
- It can cause damages to structures, result in loss of life, injury to thousands of peoples and disrupts the social and economic functioning of the affected areas

Definition

A earthquake is a sudden, violent shaking of the ground caused by two plates of earth crust sliding past one another.

- ✓ Earthquake strike suddenly without any warning, but identifying potential hazards and planning can reduce the threat damage, injuries and loss of life.
- ✓ The earthquake vibrations originate from the point of initiation of rupture and propagates in all directions.
- ✓ There are three types of waves. They are

- 1. Primary waves (P-waves)**
- 2. Secondary waves (S-waves)**
- 3. Surface waves**

Primary waves (P-waves)

- ✧ It is the fastest waves
- ✧ It is the first to reach any particular location after an earthquake occurs
- ✧ It travel through the earth crust average speed of about 5km/s
- ✧ It can pass through solid, liquid and gases
- ✧ Building experience push and pull as primary waves pass through the ground

Secondary waves (S-waves)

- ✧ It is the second seismic waves to arrive at any particular location after an earthquake
- ✧ It travel through earth's interior at about the half speed of primary waves
- ✧ It passes through solid materials like rocks
- ✧ Unlike primary waves it cannot pass through liquids or gas
- ✧ It moves small buildings back and froth as they pass

Surface waves

- ✧ Surface waves are the seismic waves that moves along the earth's surface not through its interior
- ✧ These waves travel slowly when compared to other types of seismic waves
- ✧ Surface waves cause the largest round movements and the most damage
- ✧ They make the ground roll up and down or shake side to side

CAUSES OF EARTHQUAKE

- The earthquake crust consists of 7 large lithospheric plates and numerous small plates
- These plates moves **towards each other (convergent boundary), apart (divergent boundary), past each other (transform boundary)**

- Earthquakes are caused by sudden release of stress along faults in the earth crust
- **Fault**-it is the thin zone of crushed rock separating blocks of earth
- The resulting waves of seismic energy propagate through the ground and over its surface, causing the shaking is considered as earthquake

Types of earthquake

1. **Tectonic earthquake**
2. **Induced earthquake**
3. **Volcanic earthquake**
4. **Collapse earthquake**

Tectonic earthquake

- ✓ Earthquake caused by tectonic plate are called tectonic earthquake
- ✓ They usually occur at the boundaries of tectonic plates

Induced earthquake

It is caused by human activity like tunnel construction, fracking projects (pumping large amount of fluid under high pressure into a drilled hole to break the rock that will release gas or oil)

Volcanic earthquake

- ✓ It is associated with active volcanism
- ✓ They are not powerful as tectonic quakes and often occurs relatively near the surface

Collapse earthquake

It can be occurred by such phenomena such as cave-in, mostly areas close to mining activities as a result of collapse

IMPACTS OF EARTHQUAKE

Economic impact

- Loss of life
- Loss of communication
- Loss of property and money
- Affects the mental health

Economic impact

- Loss of immovable assets
- Loss of movable assets
- Economic loss due to business interruption
- Loss of income due to jobless

Political impact

- Economic problems such as rising fund
- Rising transport and food cost
- Consultation with political advisors

Psychosocial impact

- Depression
- Consuming excessive alcohol
- Feeling insecurity
- Other mental health conditions

Preventive measures

- ◆ Listen to the radio, television and follow the instructions issued by the authorities
- ◆ Participate in disaster training
- ◆ Always prepare to carry an emergency kit
- ◆ Create social awareness programmes
- ◆ Construct the building more resistable

Do's

- ✓ Cover your mouth with hand kerchief or clothing
- ✓ Teach all family members how and when to turn off gas, electricity and water
- ✓ Keep calm
- ✓ Stay away from glass windows, doors, almirahs, mirrors,...etc
- ✓ Stay away from falling plaster, bricks or stones
- ✓ Get under table or a sturdy cot so that you are not hurt by falling object
- ✓ Stay under strong desk or table
- ✓ Go to open space
- ✓ If you are in bed, stay there and cover your head and neck with a pillow
- ✓ If you are in kitchen, quickly try to turn off stove, if possible

Dont's

- ✓ Do not run through streets, lamps may fall on you
- ✓ Do not crowd around damaged areas or buildings
- ✓ Don't move around damaged areas or buildings
- ✓ Don't move the seriously injured person wait for the medical help to arrive
- ✓ Do not return home until officials declare it is safe

LANDSLIDE

- Landslide are very common and occur in a variety of forms
- It is composed of mud or may contain rocks and other debris
- Most landslide occur gradually, but some may be sudden

Definition

A landslide is a rapid mass movement of soil, mud and or rocks downhill due to the pull of gravity

CAUSES OF LANDSLIDE

- ✧ Heavy rainfall
- ✧ Earthquake
- ✧ Geologically weak materials
- ✧ Deforestation
- ✧ Erosion
- ✧ Construction of buildings
- ✧ Vibrations of machines
- ✧ Blasting

TYPES OF LANDSLIDES

- 1. Debris flow**
- 2. Earthflow**
- 3. Debris slide**
- 4. Rock avalanche**
- 5. Shallow landslide**
- 6. Deep-seated landslide**

Debris flow

- ✓ Slope material that becomes saturated with water may develop into a debris flow or mud flow
- ✓ The resulting slurry of rocks and mud may pick up trees, houses and cars
- ✓ Thus blocking bridges and tributaries causing flooding along its path

Earthflow

- ✓ An earthflow is the downslope movement of mostly fine grained material
- ✓ It occurs more during high precipitation
- ✓ They are slow moving and are covered with solid material carried along by flow

- ✓ The velocity of the earthflow depend on the water content
- ✓ The higher the water content in the flow, the higher the velocity will be

Debris slide

- ✓ It generally starts with big rocks that start at the top of the slide and begin to break apart as they slide towards the bottom
- ✓ This is slower than a debris avalanche
- ✓ Debris avalanche are very fast and the entire mass seems to liquefy as it slides down the slope
- ✓ This is caused by a combination of saturated material and steep slopes

Rock avalanche

- ✓ A rock avalanche is also referred as struzstorm
- ✓ It is large and fast moving landslide
- ✓ The run-out distance of a rock avalanche often exceeds several kilometers and cause serious damage
- ✓ They typically result in the weakening of the sliding mass as the speed increases

Shallow landslide

- ✓ A landslide in which the sliding surface is located within the soil mantle (typically to a depth from few centimeters to some meters) is called shallow landslide
- ✓ It often happens in areas that have slopes with high permeable soils on top and low permeable soils on bottom
- ✓ The low permeable bottom soil traps the water in the shallower, high permeable soil creating high water pressure in the top soils
- ✓ As the soils are filled with water and become heavy, slopes can become very stable and slide very the low permeable bottom soils

Deep seated landslide

- ✓ Deep seated landslide are those in which the sliding surface is mostly deeply located below the maximum depth of trees (10m)
- ✓ They typically move slowly, only several meters per year ,but occasionally move faster
- ✓ This type of landslide occurs in tectonic active region like Zagros mountain in Iran

IMPACTS

Social impact

- Loss of life
- Loss of communication
- Damages to property

- Damages the roads and railways
- Leads to injuries

Environmental impact

- Loss of natural resources
- Landslide materials can block river streams
- It also pollute the water bodies

Economic impact

- Reduced real estate valued in areas threatened by landslides
- Interruption in transport system
- Loss in industrial and agricultural productivity

Health impact

- Rapidly moving water and debris that can lead to trauma
- Broken electrical wire, gas and sewage lines that can result in injury
- Disrupted roadways can endanger motorists

Political impact

- Government- its stability and participation
- Economic problems
- Consultation with political advisors

Psychosocial impact

- Depression
- Feeling insecurity
- Other mental health condition

Preventive measures

- ❖ Building roads in low landslide risk areas
- ❖ Before constructing the building, identify the soil type
- ❖ Provide proper drainage system
- ❖ Participate in disaster training
- ❖ Always prepare to carry an emergency kit
- ❖ Provide retaining walls to avoid the debris
- ❖ Grow more trees that can hold the soil through roots
- ❖ Stay alert and awake
- ❖ Listen for unusual sounds such as trees cracking or boulders knocking together
- ❖ Conduct social awareness programmes

Do's

- Prepare tour to hilly region according to information given by the weather department or news channel

- Move away from landslide path or downstream valleys quickly without wasting time
- Keep drains clean
- Inspect drains- for leaves, plastic bags
- Try to stay connected with family and companions
- Check for injured and trapped person
- Mark the path of tracking so that you can't be lost in the middle of the forest
- Know how to give sign or how to communicate during emergency time to flying helicopters and rescue them

Dont's

- Try to avoid construction and staying in vulnerable areas
- Do not panic and loose energy by crying
- Don't touch anything or walk on loose materials, electrical wire..etc
- Don't drink contaminated water directly from rivers, springs..etc
- Don't move the injured person without giving first aid unless the casualty is in immediate danger

FLOOD

- Floods are the common natural disasters that can affect millions of people around the world
- They destroy houses and buildings and carry soil away from vulnerable farming land
- Floods can also contaminate drinking water and lead to diseases

Definition

- It is an overflow of water that submerges the land ie, usually dry.
- It occurs from river,lake..etc that overflows or breaks resulting in escape of water

CAUSES OF FLOOD

- ❖ Heavy rain
- ❖ Failure dam
- ❖ Failure of river embankment
- ❖ Lack in provision of drainage system
- ❖ Melting of snow

TYPES OF FLOOD

- Flash flood
- Coastal flood
- River flood

- Urban flood
- Pluvial flood

Flash flood

- ✓ Flash flood are fast moving waters that sweep everything in their path
- ✓ They are caused by heavy rainfall or rapid snow thaw
- ✓ Flood usually cover a relatively small area and occur with little to no notice,generally less than 6 hours
- ✓ The rapid water can move large objects such as car, rocks and trees

Coastal flood

- ✓ Coastal flood are caused by strong winds that move towards a coast during high tide
- ✓ When powerful waves breach the coast's dune, the area is usually flooded
- ✓ Coastal areas with fewer defenses and lower elevation are the most affected
- ✓ The best time to repair the breach is during low tide
- ✓

River flood

- ✓ It is characterized by gradual river bank overflows caused by extensive rainfall over an extended period of time
- ✓ The areas covered by river floods depend on the size of the river and the amount of rainfall
- ✓ River flood rarely results in loss of lives but can cause immense economic damage

Pluvial flood

- ✓ Pluvial flood form in flat areas where the terrain can't absorb the rain water, causing puddles and ponds to appear
- ✓ Pluvial flooding is similar to urban flooding, but it occurs mostly in rural areas
- ✓ The agricultural activities and properties in areas where pluvial floods have occurred can be easily affected

IMPACTS

Social impact

- Loss of people
- Many people will be homeless
- People will be affected by diseases
- Electricity supply will be cut off

Economic impact

- Import and export business will be cut off
- Damages to roads and buildings
- Damages to irrigation system
- Crops will be destroyed by flood, so the farmers will be affected

Environmental impact

- Remove nutrients from the soil
- Increase in water pollution
- Destroys crops and plants
- Chemicals and other environmental hazardous material will end up in water and got contaminated

Health impact

- Water-borne diseases will start to spread
- Leads to injuries
- Lack of food and drinking water

Political impact

- Government- its stability and operations
- Leads to economic problems
- Consultation with political system
- Other mental conditions
- Income to the rescuers

Psychosocial impact

- Depression
- Feeling security
- Other mental health condition

Preventive measure

- Gather the emergency supplies previously stocked in your home
- Stay tuned to local radio or television station for updates
- Learn about your communities emergency plans location of shelter
- Post emergency phone numbers at every phone
- Always carry an emergency kit
- Turn off all supplies, equipments or main switch

Do's

- Stay calm
- Monitor the radio or television for weather updates
- Drink boiled water
- Eat fresh food and keep your food covered
- Return home only when the authorities say it safe

- Snakes and other animals may be in your house so wear heavy gloves and boots during cleaning

Dont's

- Don't panic
- Don't swim in running water
- Don't drive in running water
- Don't turn on power supply until the EB connection is checked
- Don't drink contaminated water
- Don't walk and drive on the bridges
- Don't stay under damaged buildings

DROUGHT

- Drought is a prolonged dry period in natural climate change
- It is a slow-onset phenomenon caused by rain deficit
- It often result in mass displacement in population
- It leads to water and food shortages and is likely to have a long term environmental, economic and health impact on the population

Definition

- ✓ Drought occurs due to below average rainfall that result in shortage of water supply that is surface water or ground water
- ✓ It can last for months or many years or may be few days
- ✓ It affect the ecosystem and agriculture and harmful to economy

CAUSES OF DROUGHT

- Deforestation
- Climate change
- Deficiency in rainfall
- Change in weather condition
- El Nino

TYPES OF DROUGHT

1. Meteorological drought
2. Hydrological drought
3. Agricultural drought
4. Socioeconomic drought

Meteorological drought

Meteorological drought is mainly caused due to lack of precipitation for a prolonged period of time

Hydrological drought

- ✓ It refers to low volume of water in streams, lakes, reservoirs..etc lasting months or rivers

- ✓ Hydrological drought usually related to meteorological drought
- ✓ Change in water level affects the ecosystem

Agricultural drought

- ✓ Various characteristics like rainfall shortages, reduced ground water..etc
- ✓ It has the link between meteorological and hydrological drought
- ✓ It affects the crop production
- ✓ Poorly planned agriculture crops cause lack of water

Socioeconomic drought

- ✓ It is associated with the supply and demand of some economic good with elements of meteorological, hydrological and agricultural drought
- ✓ It depends on supply and demand
- ✓ Demand for economic goods (food and water) increasing as a result population growth and economic development
- ✓ Supply increase because of improved technology or construction of reservoirs
- ✓ When both supply and demand increase the critical factor has relative change
- ✓ Socioeconomic drought is formed when the demand for water for economic activities far exceeds the supply

IMPACTS

Social impact

- Drought leads to poverty and hunger
- Affects the human health due to scarcity of water
- Loss of human life
- Health problems related to dust

Environmental impact

- Drought leads to death of water animals
- Leads to zero soil moisture
- Quality and health of surface water such as rivers, streams, lakes will be affected
- Wildlife will be affected
- Dust will be formed

Economic impact

- Farmers have to spend lot of money for irrigation and watering animals
- Low yield equals to loss of income
- Business and industry that produce from equipment may shut down
- People have to pay more to get food

Political impact

- The government fail to give adequate equipment to the farmers for crop production
- No investment in rural areas
- Political instability
- Corruption

Health impact

- Allergies due to dust
- Lack of water leads to various disease
- Affects human respiratory systems

Psychosocial impact

- Stress
- Anxiety
- Depression
- Mental health disorder

Preventive measures

- Proper selection of crops for drought affected areas
- Education and training of people
- Save water in reservoirs, streams..etc
- Plant more trees
- Recycle the water in useful way

Do's

- ✓ Implement rain water harvesting
- ✓ Advice the farmers for taking up drought resistant crops and crop requiring less water
- ✓ Optimum usage of water
- ✓ Awareness programs should be conducted
- ✓ Teaching through education

Dont's

- ✓ Don't waste more water for bathing and washing clothes
- ✓ Avoid unnecessary flushing of water in toilets
- ✓ Do not waste drinking water, as it is precious
- ✓ Don't let the tap to run water while brushing or washing the face
- ✓ Clean vegetables in a pan filled with water rather than running water from the tap

FIRE OR WILDFIRE

- ✓ Forest have been an integral part of human ecosystem
- ✓ Wildfires are natural phenomenon that have occurred for many million of years
- ✓ It is very common, very difficult to fight and may be dangerous
- ✓ Depending on the type of vegetation present, a wildfire can also be classified

Definition

- Wildfire or wildland fire is an uncontrolled fire that occurs at large field areas of land
- It commonly occur during hot and dry season
- Typically fire starts out of a lightning strike or people carelessly started it or accidentally, or even arson that went un-noticed and got out of land
- These fires sometimes burn for days and weeks
- They can wipe out entire forest and destroy almost every organic matter in the forest

Causes of wildfire

1. Natural causes

- Lightning that strikes on the trees set to fire
- However, rain extinguish such fires without causing much damage
- High atmospheric temperatures and dryness offer favourable circumstances for a fire to start

2. Man-made causes

- Fire from cigarette
- Electric spark
- Any sources in contact with flammable materials
- Arson
- Campfire

Types of wildfire

1. Forest fire
2. Surface fire
3. Ground fire
4. Crown fire
5. Underground fire
6. Firestorm

Forest fire

- ✓ A forest is an entire ecosystem consists of

Biotic factors like animals, insects, birds, plants and trees

Abiotic factors like water, rocks..etc

- ✓ If the wildfire strikes in such ecosystem, all the life forms will be lost

- ✓ Air, water, soil will be polluted

Surface fire

- ✓ Surface fires burn only surface litter (twigs and dry grasses), fallen branches..etc
- ✓ These are the easiest fires to put out and cause the least damage to the forest

Ground fires

- ✓ Fire burns the organic material in the soil is called ground fires
- ✓ It is slower burning fire under litter or under vegetation
- ✓ They burn by glowing combustion

Crown fires

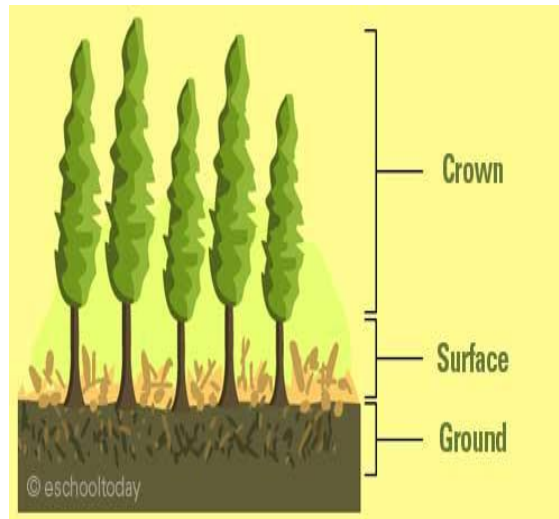
- ✓ A crown fire is one in which the crown of the trees and shrubs burn by a surface fire
- ✓ A crown fire is particularly very dangerous in a coniferous forest because resinous material given off burning logs burn furiously
- ✓ On hill slopes, if the fire starts downhill, it spread up fast as heated air adjacent to a slope tends to flow up the slope spreading flames along with it

Underground fire

- ✓ In dense forest, a thick mantle of organic matter is find on top of the mineral soil
- ✓ This fire spreads in by consuming such materials
- ✓ These fires usually spread entirely underground and burn for some meters below the surface
- ✓ This fire spreads very slowly and in most of the cases it becomes very hard t detect and control such types of fires
- ✓ They may continue to burn for months and destroy vegetative cover of the soil

Firestorms

- ✓ Among the forest fires, the most rapid spread fire is firestorm
- ✓ As the fire burns, heat rises and air rushes in, causing the fire to grow
- ✓ More air makes the fire spin violently like a storm
- ✓ Flames fly out from the base and burning start smaller fires around it
- ✓ Temperatures inside these storms can reach around 2000 degree Fahrenheit



IMPACTS

Social impact

- Loss of livelihood for the tribal people and rural areas
- People fighting the fire often lose their lives
- Various diseases will be formed
- Lack of tourism

Environmental impact

- Global warming is increased
- Extinction in plants and animals
- Loss in natural resources
- Leads to air pollution
- Loss of wildlife habitat
- Loss of valuable timber resources

Economic impact

- Cost lots of money to fight a forest fire and recover from it
- Lack of tourism leads to low income

Political impact

- Economic problems
- Corruption
- Food, water, shelter for injured people..etc

Health impact

- Leads to respiratory problems
- Irritation to eyes, nose, throat..etc
- Leads to lung disease

Psychosocial impact

- Anxiety
- Fear depression
- Other mental health hazards

Preventive measures

- Modern fire fighting like the early forest fire detection using radio acoustic sounding..etc
- Use of modern fire detection and monitoring systems with the help from the Forest Survey in India (FSI) and ISRO
- Prevention of forest fire through law and education
- Creating awareness among locals along with participation can be a better solution
- Keep the fire service number handy

Do's

- Listen regularly to radio for advance information and obey the instruction
- Move the farm animals and move the goods to safer place
- Teach the causes and harm effects of fire to your family
- Make the people stay awake about forest fire safety

Don'ts

- Don't throw smoldering cigarette butts or beedi in forest
- Don't leave the burning sticks or wood in forests
- Don't enter the forest during fire
- Don't be scared while sudden fire occurs in the forests

MAN-MADE DISASTER

- ✓ Man-made or technological disasters are unpredictable, can spread across geographical boundaries, may be unpreventable, and may have limited physical damage but long term effects.
- ✓ Some disasters in this class are entirely man-made, such as terrorism, bio-war.etc

Definition

- ✓ Man-made disaster is a disaster which is caused due to human intent, negligence or error that results in loss of social, economic, environment.
- ✓ Man-made disaster can be both intentional and unintentional that results in huge loss of life and property

Types of man-made disaster

1. Nuclear and radiological disaster
2. Biological disaster

3. Chemical disaster
4. Terrorism

Nuclear and radiological disaster

It is defined as the disaster that led to significant consequences to people, the environment by releasing large amount of radiation exposure

Causes of nuclear disaster

- ✓ Loss-of-pressure-control accident
- ✓ Loss-of-coolant accident (LOCA)
- ✓ Uncontrolled power excursion or, in reactors without a pressure vessel
- ✓ Fire within the reactor core
- ✓ Failures in control systems may cause a series of events resulting in loss of cooling

Effects of nuclear disaster

- ✓ Loss of life
- ✓ Affects the respiratory system
- ✓ Defects in child birth
- ✓ Environment will be affected
- ✓ Radiation damages the DNA
- ✓ Leads to blindness, cancer..etc

Preventive measures

- ✓ Plant more trees
- ✓ Stay inside and close doors/windows.
- ✓ Cover all food, water and consume only such covered items
- ✓ Alerting the plant personnel by sounding the emergency siren and making an emergency announcement.
- ✓ Regular maintenance
- ✓ Equipment and materials for handling a nuclear emergency are kept at a designated place
- ✓ Formation of rescue teams and activation of a treatment area

Examples of nuclear disaster

1. The Chernobyl disaster, 26 April 1986
2. Hiroshima and Nagasaki, 6th August 1945

Biological disaster

- Biological disasters define the devastating effects caused by an enormous spread of a certain kind of living organism
- That may the spread a disease, virus, or an epidemic.
- Biological disasters can also be simply, a sudden growth in the population of a certain kind of plants or animals

Causes of biological disaster

- ✓ Epidemics caused by animals to peoples..etc
- ✓ Typhus and Plague spread
- ✓ Accidental release of virulent microorganism or Bioterrorism (BT)
- ✓ Poor sanitation practices

Types of biological disaster

1. Epidemic Level
2. Pandemic Level

Epidemic Level

It indicates a disaster that affects many people in a given area or community

Pandemic Level

It indicates a disaster that affects a much larger region, sometimes an entire continent or even the whole planet.

- For example, the recent Covid-19, Swine Flu..etc

Effects of biological disaster

- Lead to diseases, illness, disability
- Loss of life
- Increased in poverty
- Socioeconomic disruptions
- Environmental degradation
- Difficult to detect and control

Preventive measures

- Personal hygiene like washing hands before and after work or before and after wearing protective clothing with liquid soap
- Personal Protection Equipments include masks, gloves, protective clothing, eye shield, face shield, and shoe covers
- Government actions like visiting house, pouring insecticide, pesticide..etc
- Isolation wards in hospitals
- Creating awareness programmes to peoples

Examples of biological disaster

- Covid-19
- Swine flu
- Malaria

Chemical disaster

- ✓ A chemical disaster is the unintentional release of one or more hazardous substances which could harm human health, environment, economic
- ✓ Chemical hazards are systems where chemical accidents could occur under certain circumstances.
- ✓ Such events include fires, explosions, leakages or release of toxic or hazardous materials that can cause people illness, injury, or disability.

Causes of chemical disaster

- ✓ Human error
- ✓ Improper skills
- ✓ Manufacturing defects
- ✓ improper maintenance

Types of explosion

1. Chemical explosion
2. Physical explosion

Chemical explosion

- ✓ Chemical explosions in plant or in vessel can arise due to exothermic reaction occurring internally.
- ✓ Heating and increase of molecular number can result in a rise in pressure to the bursting point of the vessel

Physical disaster

It occurs simply due to over pressure as in the case of steam boiler and air receiver explosions.

Effects of chemical disaster

- Leads to organ damage
- Development of allergies and asthma
- Leads to cancer
- Reproductive problems and birth
- Effects the mental, physical development of children
- Loss of lives, property
- Environment will be polluted

Preventive measures

- Proper maintenance, inspection should be carried out in the industries
- Construction of houses near industries, factories,..etc should be avoided
- Do not consume the uncovered food or water
- Do not re-enter the building until given the all- clear by the gas company
- keep the emergency number in your phones

- As soon as the emergency alarm is given, evacuate from the place

Examples of chemical disaster

1. The Bhopal Gas Tragedy, December 2-3, 1984
2. Vishakapatnam gas leak, 7 May 2020

Terrorism

- This is another type of disaster that results in loss of human life and property
- Terrorists use violence and strike without warning
- They use bombs, guns etc for attacking

Causes of terrorism

- Religious
- Political
- Injustice
- Madness
- Poverty

Effects of terrorism

- Loss of lives
- Loss of property
- Damages to buildings
- Depression
- Feeling insecurity

Preventive measures

- If we cross any suspicious group inform to police
- We must stay away from suspicious things
- Do not accept packages from strangers

Example

1. Pulwama Attack, 14 February, 2019
2. Ahmedabad bombings, 26 July 2008

DIFFERENTIAL IMPACT

The term differential impact is experienced by the different individual, communities or groups when faced with an event with a damaging impact.

➤ With respect to the impact of disasters (natural or man-made) a community or society can be broadly classified into following groups

1. females, males
2. poor, rich
3. labourer
4. children, old people
5. disabled

CASTE

- Scheduled Caste people are inhabited at low land areas
- Housing condition of these people are dangerous and risk
- During flood they have no space to take shelter, neither the higher caste people allow them to take temporary shelter in their houses.
- Poverty and disaster make them worse.
- Lack of information about a possible disaster make threat to their lives and livelihood
- Scheduled Tribe people inhabited at the foot of the hills and mountain and flash flood wash them away

CLASS

- Class is based on political and economic status
- loss in infrastructure
- loss in economic
- People with low income will be affected

GENDER

- Gender refers to the socio-cultural definition of man and woman, the way in which they are differentiated and assigned socially acceptable roles
- Role of men as protectors may place a greater responsibility on them for risk taking during and after a disaster
- Identifying the lives of men and women
- Temporary shelter
- Violence against women
- Pregnant women feeding their children will be affected

AGE

- Youngest and oldest people are mostly impacted destructively during any disasters for that matter.
- Decrease in strength
- Unable to hear
- Difficult in evacuation
- Difficult in getting relief and compensation money

LOCATION

- People living in the low land area, river sides, side of the river embankment, Sea coast lines are most prone to be affected by the natural calamities.

- Places often prone to volcanoes.
- Places more prone to earthquake.
- Places prone to industrial plants.

DISABILITY

- Visually challenged
- Hearing impaired
- Physically disabled
- Mentally challenged
- Unable to hear danger signals, alarms, etc.
- Difficulty in evacuation & protection
- Difficulty in getting access to relief and compensation money
- Difficulty locating avenues of escape
- Have to face the shock of losing all that they had attained in life(Home,Family,Security)

GLOBAL TRENDS IN DISASTER

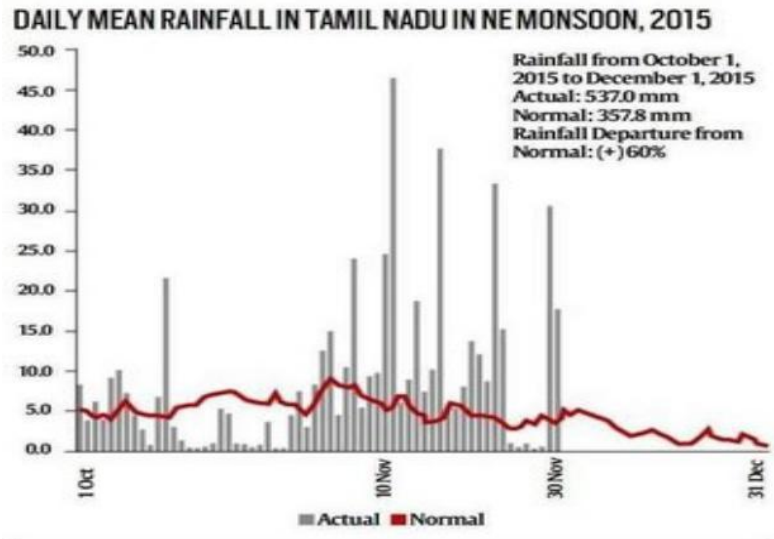
- A general development or change in situation that affects many countries and peoples in the world
- It shows the number of reported disaster and people affected

URBAN DISASTER

- ✓ The urbanization of the world's population is accelerating
- ✓ By 2008, more than 50 percent of the global population was already with more than 1 billion people living in slums
- ✓ The mega centre of urbanization suggests that by 2050 more than 67 percent of the population will be increased
- ✓ With climate change and other problems threat the urban poor and population are particularly at risk
- ✓ The key aspects such social, economic, technological and natural system function different in urban areas
- ✓ We must develop necessary response to the rising urbanization trend to meet the world

EXAMPLE

- Chennai flood in November–December 2015
- More than 500 people were killed
- Over 18 lakh people were displaced
- With estimates of damages and losses ranging from nearly 200 billion to 1 trillion



IMPACTS

- It leads to loss of unemployment
- Increase in price for food • Increase in price for shelter • Demand for water will be high • Lack in financial and physical assets such as property, money..etc

MEASURES

- Changing the approaches and development activities
- Developing new skills and capacities

PANDEMICS

- ✓ Pandemics are the diseases that occur in world wide scale and traditionally caused by infectious diseases such as influenza
- ✓ They are unpredictable in their timing, but recent history indicates that influenza pandemics expected to occur in every 10 to 15 years
- ✓ Almost all human will be vulnerable, so the government should plan the preventive measures that can be carried out
- ✓ The overall strategy for responding to an emerging pandemics is to plan number of measures

IMPACTS

- It arise rapidly and spread quickly
- It make the people very ill and likely to die
- Individual behaviour changes such as fear at workplaces
- It occurs in several waves, each lasting for several months
- It cause significant wide spread increasing in morbidity and mortality

MEASURES

- Slow the spread of the pandemic virus by sanitation system
- Encouraging social distancing, personal hygiene management strategies
- Awareness programs should be conducted
- Care and treatment for the ill
- Successful planning and response
- Cost effective strategies should be adopted

COMPLEX EMERGENCIES

A complex emergency is a major humanitarian crisis that is often the result of a combination of political instability, conflict and violence, social inequities and underlying poverty.

- A humanitarian crisis in a country, region or society where there is total or considerable breakdown of authority resulting from internal or external conflict
- On national level, conflict may involves war like encounters between armed groups from the same country which takes place within the borders
- Such outbreaks leads to
 1. Large scale medical problems
 2. Lack of water
 3. Accumulation of rubbish
 4. Food shortage..etc

IMPACTS

- People livelihood will be affected
- Loss of property
- Environment will be affected
- Ground water contamination due chemicals..etc

MEASURES

- Public awareness should be increased
- Co-ordination between NGO's provide better solution
- Strengthening humanitarian law
- Government should take strict actions

CLIMATE CHANGE

- Changing the climate across a wide range of observations
- Global warming of the past 50 years is primarily due to human activities
- Magnitude of climate change depend upon amount of heat

- Scientists and engineers from around the world have combined the evidence using satellite, weather balloons, thermometer and many other types of observing systems that monitors the earth's weather and climate.
- The sum total of this evidence tells i.e, the planet is warming
- According to the **environment ministry**, in 2018-19, about 2400 Indians lost their lives to extreme weather events such as floods and cyclones
- Farmers are the one who is mostly affected by climate change
- Due to high temperature, construction workers will be affected
- According to the **International labour organisation**, the loss of productivity by 2030 because of heat stress could be equivalent of India losing 34 million full time jobs

IMPACTS

- Affects the human health
- Continuous change of climate cause infectious disease
- Environment will be polluted
- Cutting down of trees increase the heat
- Change in climate makes the farmers hurt

MEASURES

- Plant more trees
- Continuous monitoring of weather
- Maintain energy efficient vehicle
- Implement rain water harvesting
- Farmers can ask advice to government about the cultivation of crops

UNIT-2

APPROACHES TO DISASTER RISK REDUCTION (DRR)

Disaster risk reduction

Disaster risk reduction (DRR) is a systematic approach to identifying, assessing and reducing the risks of disaster. It aims to reduce socio-economic vulnerabilities to disaster as well as dealing with the environmental and other hazards that trigger them.

Disaster cycle

The ongoing process by which governments, businesses, and civil society plan for and reduce the impact of disasters, react during and immediately following a disaster, and take steps to recover after a disaster has occurred.

KEY NOTES FOR DISASTER

- **Mitigation** - Minimizing the effects of disaster.
Examples: vulnerability analyses; public education.
- **Preparedness** - Planning how to respond.
Examples: preparedness plan, emergency training..etc
- **Response** - Efforts to minimize the hazards created by a disaster.
Examples: search and rescue; emergency relief .
- **Recovery** - Returning the community to normal.
Examples: reconstruction of housing; medical care

PHASES OF DISASTER

The four phases of disaster:

- 1) Mitigation
- 2) Preparedness;
- 3) Response
- 4) Recovery

Mitigation

- Disaster mitigation work involves directly preventing future emergencies and/or minimizing their negative effects.
- It requires hazard risk analysis and the application of strategies to reduce the likelihood that hazards will become disasters, such as flood-proofing homes or buying insurance.

The mitigation activities are to:

- Protect people and structures.
- Reduce the costs
- Restricting deforestation to prevent slides
- Construction of roads and bridges to withstand the disaster
- Awareness through social medias

Preparedness:

- Disaster preparedness efforts include plans or preparations made in advance of an emergency that help individuals and communities get ready.
- Such preparations might include the stocking of food and water or the gathering and screening of willing volunteers, ready to mobilize post-disaster.

The goals of preparedness activities are

- Planning, assigning, and training staff who can assist in areas of response operations.
- Identifying resources and supplies that may be required in an emergency

Response:

- It addresses immediate threats presented by the disaster including saving lives, meeting humanitarian needs (foods, shelter, clothing, public health and safety), cleanup and start resource distribution
- The actions taken before increasing mortality and morbidity and to prevent further property damage when an event occurs

Response activities include:

- Applying intelligence and other information to lessen the effects or consequences of an incident.
- Increasing security operations.
- Continuing investigations into the nature and source of the threat.
- Ongoing public health and agricultural surveillance

Recovery

- Actions taken to return a community to normal or near-normal conditions, the repair of physical, social and economic damages
- Recovery begins right after the emergency
- It can be divided into two periods.

SHORT TERM : This phase lasts from 6 months to atleast one year
LONG TERM : Range upto decades requires strategic planning and action to the impacts of disaster

The recovery activities are

- Identify needs and define resources.
- Provide housing
- Address long-term care and treatment of affected persons.
- Implement additional measures for community restoration.
- Evaluate the incident to identify lessons learned.

Community based disaster preparedness (CBDP)

Definition

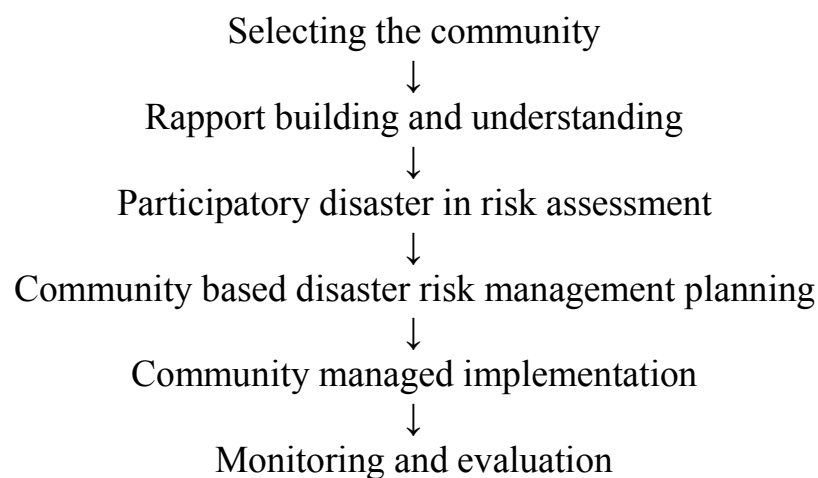
CBDP is a community-centered approach to disaster preparedness in which community support systems and sustainable coping mechanisms are strengthen and collective knowledge and capacities are applied to reduce the adverse impacts of disasters

Objectives

- To understand how community people can take the help of resources/NGOs for disaster preparedness
- To reduce the vulnerabilities of disaster and improve the community
- Successful disaster preparedness strategies involve careful efforts to combine knowledge, technology, skills and practices

STAGES IN DISASTER RISK REDUCTION

Disaster risk reduction process has 6 sequential stages.Each stages leads to further actions



1. Selecting the community

- It is the first task of NGOs to conduct a detailed risk assessment survey of the whole area
- The selection of communities implementation of CBDP activities depends upon a number of factors and criteria

Criteria for identifying communities for CBDP activities

- Most vulnerable exposure to risk
- Poverty status of the community
- Government priority of physical, social, and economic vulnerability
- Budget availability

2. Rapport building and understanding

- This step is usually involves interacting and integrating with the community and gathering information to have a general description of the community
- Once the most vulnerable communities are identified it is important to understand local social relationship to build good informal relationship with the local people
- The NGOs who support the community in disaster preparedness need to build a picture of nature , needs and resources of the community

3. Participatory disaster risk assessment

- It is the process of identifying the risk that communities, villages face and how people overcome those risk
- This will be conducted in most vulnerable and priority communities
- This process involves hazard assessment, vulnerability assessment and capacity assessment, analysis and prioritization of risk
- The participatory risk will be conducted by NGOs with the involvement of local people, community

4. Community based disaster risk management planning

- At this stage the further analysis will be conducted jointly by NGO's and communities to analyse the risk and identify strategies and solutions to address them
- Based on this a detailed risk reduction and response plan will be developed for the particular communities
- Roles and responsibilities of the various stakeholders for implementation of activities will be clarified

5. Community managed implementation

- The implementation of plan should be done through the community organization at community level with the support from NGO and other technical institution
- The implementation process will include various structural and non structural activities
- The community based organization would be responsible for overall management of the disaster reduction activities
- The NGO plays a facilitating and coordinating roles for the implementation of the community plan and resources

6. Monitoring and evaluation

Participatory monitoring and evaluation (PME) involves local community, development agencies, NGOs , local authorities , PRI members and other stakeholders in measuring the progress made and identifying necessary action to be followed.

RISK ASSESSMENT

The **identification, evaluation, and estimation** of the levels of risks involved in a situation or a hazard

The overall process or method

1. Identify hazards and risk factors that have the potential to cause harm (**hazard identification**).
2. Analyze and evaluate the risk associated with that hazard (**risk analysis, and risk evaluation**).
3. Determine appropriate ways to eliminate the hazard, or control the risk when the hazard cannot be eliminated (**risk control**).

STRUCTURAL MEASURES IN DRR

Any physical construction to reduce possible impacts of hazards i.e, engineering techniques or technology to achieve hazard resistance

- Engineering measures such as cyclone shelter is one of the key cyclone mitigation measure
- Very high resolution satellites are being used for the detection of tectonic movement of the earth
- Earthquake resistant design of buildings depends upon providing the building with strength, stiffness and inelastic deformation capacity

which are great enough to withstand a given level of earthquake-generated force.

- Strengthening disaster warning system for flood, cyclone,.etc providing proper drainage prevents flood
- There are several different experimental techniques that can be used to test the response of structures to verify their seismic performance

NON STRUCTURAL MEASURES IN DRR

Non-structural measures are measures not involving physical construction which use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education

- ✓ Policies for infrastructure Planning and Development in the flood plains
- ✓ Disaster Preparedness & Response Planning
- ✓ Flood Forecasting and Warning.
- ✓ Evacuation and shelter management
- ✓ Home placed at higher elevations and built with flood resistant materials.
- ✓ Changes in cropping pattern
- ✓ Training and Public Awareness
- ✓ Flood Warning System
- ✓ Government should make strict laws
- ✓ Making awareness in schools, colleges..etc
- ✓ Conducting social programmes about disaster and how to respond during and after disaster

STATE DISASTER MANAGEMENT AUTHORITY

- ✓ A state disaster management authority is to be established by every state government
- ✓ A State Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the State Government and, unless the rules otherwise provide
- ✓ The State Authority shall consist of the following members, namely:—
 - (a)The Chief Minister of the State, who shall be Chairperson
 - (b)Other members, not exceeding eight, to be nominated by the Chairperson of the State Authority
 - (c) the Chairperson of the State Executive Committee

Powers and functions of State Authority.—

- a) Lay down the State disaster management policy
- b) Approve the State Plan in accordance with the guidelines laid down by the National Authority
- c) Approve the disaster management plans prepared by the departments of the Government of the State
- d) Lay down guidelines to be followed by the departments of the Government of the State for the purposes of integration of measures for prevention of disasters and mitigation in their development plans and projects and provide necessary technical assistance therefore
- e) Coordinate the implementation of the State Plan
- f) Recommend provision of funds for mitigation and preparedness measures
- g) Review the development plans of the different departments of the State and ensure that prevention and mitigation measures are integrated
- h) Review the measures being taken for mitigation, capacity building and preparedness by the departments of the Government of the State and issue such guidelines as may be necessary

Powers of the State Executive Committee

- a. Control and restrict, vehicular traffic to, from or within, the vulnerable or affected area
- b. Control and restrict the entry of any person into, his movement within and departure from, a vulnerable or affected area
- c. Remove debris, conduct search and carry out rescue operation
- d. Provide shelter, food, drinking water, essential provisions, health care and services in accordance with the standards laid down by the National Authority and State Authority
- e. Give direction to the concerned Department of the Government of the State, any District Authority or other authority, within the local limits of the State to take such measure or steps for rescue, evacuation or providing immediate relief saving lives or property, as may be necessary in its opinion
- f. Require any department of the Government of the State or person in charge of any relevant resources to make available the resources for the purposes of emergency response, rescue and relief
- g. Require experts and consultants in the field of disasters to provide advice and assistance for rescue and relief
- h. Procure exclusive or preferential use of amenities from any authority or person as and when required

- i. Construct temporary bridges or other necessary structures and demolish unsafe structures which may be hazardous to public
- j. Ensure that non-governmental organisations carry out their activities in an equitable and non-discriminatory manner
- k. Disseminate information to public to deal with any threatening disaster situation or disaster
- l. Take such steps as the State Government may direct in this regard or take such other steps as are required or warranted by the form of any threatening disaster situation or disaster.

Functions of the State Executive Committee

- a. Coordinate and monitor the implementation of the National Policy, the National Plan and the State Plan
- b. Examine the vulnerability of different parts of the State to different forms of disasters and specify measures to be taken for their prevention or mitigation
- c. Lay down guidelines for preparation of disaster management plans by the departments of the Government of the State and the District Authorities
- d. Monitor the implementation of disaster management plans prepared by the departments of the Government of the State and District Authorities
- e. Monitor the implementation of the guidelines laid down by the State Authority for integrating of measures for prevention of disasters and mitigation by the departments in their development plans and projects
- f. Evaluate preparedness at all governmental or non-governmental levels to respond to any threatening disaster situation or disaster and give directions, where necessary, for enhancing such preparedness;
- g. Coordinate response in the event of any threatening disaster situation or disaster
- h. Give directions to any Department of the Government of the State or any other authority or body in the State regarding actions to be taken in response to any threatening disaster situation or disaster
- i. Promote general education, awareness and community training in regard to the forms of disasters to which different parts of the State are vulnerable and the measures that may be taken by such community to prevent the disaster, mitigate and respond to such disaster
- j. Advise, assist and coordinate the activities of the Departments of the Government of the State, District Authorities, statutory bodies and

- other governmental and non-governmental organisations engaged in disaster management
- k. Provide necessary technical assistance or give advice to District Authorities and local authorities for carrying out their functions effectively
 - l. Advise the State Government regarding all financial matters in relation to disaster management
 - m. Examine the construction, in any local area in the State and, if it is of the opinion that the standards laid for such construction for the prevention of disaster is not being or has not been followed, may direct the District Authority or the local authority, as the case may be, to take such action as may be necessary to secure compliance of such standards
 - n. Provide information to the National Authority relating to different aspects of disaster Management
 - o. Lay down, review and update State level response plans and guidelines and ensure that the district level plans are prepared, reviewed and updated
 - p. Ensure that communication systems are in order and the disaster management drills are carried out periodically
 - q. Perform such other functions as may be assigned to it by the State Authority or as it may consider necessary.

State Plan

1. There shall be a plan for disaster management for every State to be called the State Disaster Management Plan
2. The State Plan shall be prepared by the State Executive Committee having regard to the guidelines laid down by the National Authority
3. The State Plan prepared by the State Executive Committee under sub-section shall be approved by the State Authority
4. The State Plan shall include,—
 - (a) The vulnerability of different parts of the State to different forms of disasters
 - (b) The measures to be adopted for prevention and mitigation of disasters
 - (c) The manner in which the mitigation measures shall be integrated with the development plans and projects

- (d) The capacity-building and preparedness measures to be taken
- (e) The roles and responsibilities of each Department of the Government of the State in relation to the measures specified in clauses (b), (c) and (d) above
- (f) The roles and responsibilities of different Departments of the Government of the State in responding to any threatening disaster situation or disaster.
- (5) The State Plan shall be reviewed and updated annually.
- (6) Appropriate provisions shall be made by the State Government for financing for the measures to be carried out under the State Plan.
- (7) Copies of the State Plan referred that are available to the Departments of the Government of the State and such Departments shall draw up their own plans in accordance with the State Plan.

PANCHAYAT RAJ INSTITUTION

- The term "Panchayati Raj" is an ancient concept adopted by the people of India for the local administration of a village.
- Raj means "rule".
- It is the basic unit of administration in a system of governance
- It is the backbone of villages/rural development for sustainable development
- The Constitutional (73rd Amendment) Act 1992 came into force in India on 24 April 1993 to provide constitutional status to the Panchayati Raj institutions
- This act was extended to the Panchayats in the tribal areas of some states, namely Andhra Pradesh, Gujarat, Himachal Pradesh, Maharashtra, Madhya Pradesh, Odisha and Rajasthan from 24 December 1996.

THREE TIER OF PRI

1. Village level- Gram panchayat
2. Block level- Panchayat samiti /mandal
3. District level- Zilla Parishad

Panchayats Role during the First Phase of Disaster Management:

The following are the major roles and responsibilities of the three - tier systems of local self government before, during and post- disaster management period.

Gram Panchayat or Village level

- Convey meetings to ensure timely warning
- Update information on civic amenities/population, etc.
- Select safe locations for people and livestock
- Arrangements to evacuate the elderly, the disabled, children and women
- Medical and sanitation facilities at relief camps
- Disconnecting power lines during high winds; storing food grain, drinking water, etc.

Block/Mandal Panchayat

- Supervise preparedness of Gram Panchayats (GP)
- Consolidate village-level information on items listed under GP
- Assessing preparedness of: primary health centres/evacuation arrangements, etc.
- Engineering staff at the Block/Mandal level should repair drainage/canal/roads, etc.
- Contact ex-army/security forces personal/volunteers to organize task force for assistance
- Procure and keep ready rescue material, including boats
- Function as link between district and village-level counter-disaster activities.

Zilla Panchayat or District level

- The District Collector/CEO should convene a meeting of all District Heads of sectoral departments and ZP members before the start of likely cyclone periods
- Initiate all concerned departments to take up necessary repair and maintenance and related works for preparedness
- Organize 'Task Forces' at district, block and village levels
- Identify NGOs useful in providing assistance during disasters
- Check inventories of items required at short notice for rescue and relief operations
- At first warning, call meeting of Crisis Management Group (CMG) and alert blocks/villages
- All CMG members should be asked to keep their personnel in full preparedness

Panchayat Role in Rescue and Relief before and during Natural Disaster impact:

Gram Panchayat or Village level

- Set up temporary shelters/relief camps after initial warning/store food and water for people/livestock
- Evacuation of people and livestock should start immediately after final warning
- Keep rescue volunteers and task forces ready
- District/block medical/relief teams may be asked to take position at strategic points and coordinate with village volunteers/task forces
- Organize veterinary aid teams for taking care of livestock and removal of carcasses
- Disposal of dead bodies and prevention of the spread of epidemics
- Assessing loss of life, livestock and damage to farming, property, etc.

Block/Mandal Panchayat

- Identify vulnerable areas and send task forces/volunteers to supervise safety measures
- Evacuate people from these areas and help GPs in organizing relief camps
- Arrange for emergency communication through police wireless/ham radio, etc.
- Arrange supply of food and other items to relief camps in adequate quantities
- Supervise rescue and relief activities with district-level officers
- Inform CMG if help is needed from police and defense forces
- Assist armed forces in rescue and relief operations
- Supervise rescue and relief and coordinate with various agencies including NGOs.

Zilla Panchayat or District level

- Monitor situation, identify blocks and villages most likely to be affected and issue warnings
- Activate control room and keep a full watch on the situation
- Arrange emergency communication with the help of police wireless/ham radio, etc.
- Put CMG on the job of assisting block and village Panchayats with counter-disaster steps
- Arrange transport for evacuation of people and livestock
- Arrange for temporary shelters/relief camps

- Seek assistance of the armed forces if necessary
- Monitor rescue and relief operations at village and block levels
- Assist lower Panchayats in mobilizing task forces/volunteers/ NGOs for rescue and relief

Role of Panchayat in Reconstruction and Long-term Mitigation Planning:

Gram Panchayat or Village level

- Assist in identifying victims for compensation, and then in its distribution
- Formulate reconstruction plans for houses, community buildings, roads, etc. within GP jurisdiction with the assistance of technical departments at block and district levels.
- Enforce minimum specifications for safe construction.
- Help district and block level organizations in arranging awareness camps for management and mitigation of disasters and ensure participation of the villagers.
- Organize village-level task force/volunteers and train them in counter-disaster measures.
- Assist in supervising and monitoring reconstruction and development projects.
- Encourage local people to insure assets/livestock, which should be mandatory for those who can afford. Seek government help for those who are too poor to afford insurance

Block/Mandal Panchayat

- Assist in rehabilitation, repair and reconstruction
- Assist gram Panchayats in identifying victims for payment of compensation and in its distribution
- Prepare village and block-level mitigation plans; consolidate/integrate these with the block plan
- Enforce minimum safety specifications for construction
- Assist in long-term mitigation planning and its integration with block/district development plans
- Supervise and monitor reconstruction and long-term mitigation projects implemented by GPs and Block Panchayats.

Zilla Panchayat or District level

- Planning and implementation of rehabilitation, repair and reconstruction
- Compensation for loss of life, property, etc.
- Hazard and vulnerability mapping
- Anti-disaster measures to be integrated in all development projects

- Special funding to use disaster-resistant construction technologies in vulnerable areas

URBAN LOCAL BODIES

- Urban Local Bodies (ULBs) are small local bodies that administer or governs a city or a town of specified population.
- The functions broadly relate to public health, welfare, regulatory functions, public safety, public infrastructure works, and development activities.
- There are several types of Urban Local bodies in India such as Municipal Corporation, Municipality, Notified Area Committee, Town Area Committee, Special Purpose Agency, Township, Port Trust, Cantonment Board etc

ROLES AND RESPONSIBILITIES OF URBAN LOCAL BODIES

Role of the ULBs Likewise, the representatives of Urban Local Bodies (ULBs) have to initiate disaster management tasks in the urban areas in the jurisdiction of municipal bodies. Their tasks include:

- ✓ Maintaining of vehicles, sanitary facilities, food, shelter and rest facilities, relief and replacement, personnel and emergency message, contact arrangement and logistic support
- ✓ Keeping unauthorized persons out of the disaster area in order to prevent looting and preventing persons from being injured in the wreckage
- ✓ Handling the dead, as mass disposal poses many problems in disasters
- ✓ Evacuating neighbourhoods
- ✓ Coordinating with volunteers
- ✓ Acquiring and allocating unusual resources
- ✓ Dealing with livestock or family pets that had to be left behind
- ✓ Disbursing large amounts of donations
- ✓ Controlling emergency vehicle traffic in order to avoid blockage of routes by emergency vehicles
- ✓ Maintaining hospital wards for emergencies
- ✓ Checking the hospitals, nursing homes and day care centres that may need assistance
- ✓ Enhancing communication that is a recurring challenge in disaster response
- ✓ Sharing and collecting information on what agencies have responded to and what resources have they dispatched;
- ✓ Determining the resources needed to undertake the counter disaster measures

- ✓ Sharing information about the location, scope, and character of the disaster and damage
- ✓ Locating and specifying procedures for obtaining special disaster resources
- ✓ Sharing information about the state of transportation route facilities, docking and landing sites
- ✓ Generating and sharing predictions about weather condition
- ✓ Obtaining information on how to deal with specific hazardous chemicals.
- ✓ Warning and communicating with the public

Institutional Framework

An institutional framework establishes the structure and relationships of governmental and non-governmental organisations, including ministries, departments, local governments, individuals and the private-sector.

Stakeholders

- Individuals, groups or organisations that have an interest or investment in the actions that will be taken to reduce disaster risks.
- Involvement of those who will be affected by disaster risk reduction actions is critical for successful development, implementation and maintenance.

ROLES AND RESPONSIBILITIES OF STATE AND CENTRAL GOVERNMENT

Following are the role and responsibilities of the govt to reduce the effectiveness of any disaster.

Pre-Disaster measures

- ✓ Keep a check and monitoring any impending disaster.
- ✓ Early warning .
- ✓ Planning and liaison with different DM agencies.
- ✓ Educating people about DM.
- ✓ Stocking relief material.
- ✓ Rehearsing drills.

During Disaster

- ✓ Launch search and rescue operations as quick as possible.
- ✓ Provide relief material.
- ✓ Transport people to safe places.

- ✓ Provide temp shelter.
- ✓ Immediately medical and health facilities.
- ✓ Provide clean water and food.
- ✓ Shift critically injured people to hospital.
- ✓ Pool all resources and DM agencies. (Include Army, Navy and Air force if required.

Post Disaster

- ✓ Analyse the damage
- ✓ Cleanup of rubble and rebuilding activities to begin.
- ✓ Preference to rebuild and restart basic amenities
- ✓ Analyse causes of disaster and future planning to tackle such disaster in future.

These are some the responsibility of our govt to tackle and minimise the damage of the disaster. Our NDRF and district administration are needed to be better prepared for any contingencies, this reducing the reaction time

ROLES AND RESPONSIBILITIES OF OTHER STAKEHOLDERS

Some of the other stakeholders are **community, media,NGOs, private sector, educational institutions, international agencies**

COMMUNITY

Mitigation

- ❖ Construction of Disaster resistant houses
- ❖ Afforestation
- ❖ Soil Conservation

Preparedness

- ❖ Insurance (Property, Crop, Livestock, etc.)
- ❖ Equipped with rescue material (First Aid kit)
- ❖ Hazard Information

Response

- ❖ Self Evacuation
- ❖ Assist in Search & Rescue
- ❖ Maintaining Public Order

Recovery

- ❖ Moral Support
- ❖ Revitalizing Neighbourhoods
- ❖ Social Justice

MEDIA

Mitigation

- ❖ Public awareness programmes
- ❖ Incite officials to adopt disaster risk reduction strategies

Preparedness

- ❖ Inform, Educate, Empower & Engage communities
- ❖ Disseminating vital information (hazard warning)

Response

- ❖ Gathering & transmitting information about the disaster affected areas

Recovery

- ❖ Counselling programmes
- ❖ Avenues for Income generation & Livelihood restoration

NGO's

Mitigation

- ❖ Awareness programmes
- ❖ Environmental Studies
- ❖ Preservation of flora & fauna

Preparedness

- ❖ Locate Evacuation sites
- ❖ Map Evacuation routes
- ❖ Community Training
- ❖ Mock Drills (Training for emergency situation)

Response

- ❖ Food & Water Supply
- ❖ Medical Aid
- ❖ Search & Rescue
- ❖ Relief Camp

Recovery

- ❖ Psycho-social support
- ❖ Mental health services

PRIVATE SECTOR

Mitigation

- ❖ Adoption of disaster resistant construction
- ❖ Environmental Studies
- ❖ Preservation of Flora & Fauna

Preparedness

- ❖ Developing innovative products (early warning.etc)
- ❖ Awareness generation programmes
- ❖ Mock Drills

Response

- ❖ Direct assistance to affected communities (food supply , medical aid, shelter etc.)

Recovery

- ❖ Employment generation
- ❖ Skill development programmes
- ❖ Counselling

EDUCATIONAL INSTITUTIONS

Mitigation

- ❖ Generate awareness through seminars, workshops & plays

Preparedness

- ❖ Training programmes
- ❖ Mock Drills
- ❖ Build Resource Inventory

Response

- ❖ Rescue & Relief Support
- ❖ School premises as an emergency shelter
- ❖ Community Kitchen

Recovery

- ❖ Psycho-social counselling
- ❖ Moral Support

INTERNATIONAL AGENCIES

Mitigation

- ❖ Assisting nations in framing disaster reduction strategies
- ❖ Conservation programmes

Preparedness

- ❖ Hazard Literacy
- ❖ Technology & Information Sharing
- ❖ Assisting nations in framing disaster reduction strategies

Response

- ❖ Relief Aid
- ❖ Technical Support
- ❖ Skilled Manpower Assistance

Recovery

- ❖ Financing Reconstruction Activities

NATIONAL DISASTER MANAGEMENT AUTHORITY

- ✓ The National Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the Central Government and, unless the rules otherwise provide,
- ✓ The National Authority shall consist of the following:—
 - (a) the Prime Minister of India, who shall be the Chairperson of the National Authority
 - (b) other members, not exceeding nine, to be nominated by the Chairperson of the National Authority.

Powers and functions of National Authority

The National Authority may —

- a) Lay down policies on disaster management
- b) Approve the National Plan
- c) Approve plans prepared by the Ministries or Departments of the Government of India in accordance with the National Plan
- d) Lay down guidelines to be followed by the State Authorities in drawing up the State Plan
- e) Lay down guidelines to be followed by the different Ministries or Departments of the Government of India for the purpose of integrating the measures for prevention of disaster or the mitigation of its effects in their development plans and projects

- f) Coordinate the enforcement and implementation of the policy and plan for disaster management
- g) Recommend provision of funds for the purpose of mitigation
- h) Provide such support to other countries affected by major disasters as may be determined by the Central Government
- i) Take such other measures for the prevention of disaster, or the mitigation, or preparedness and capacity building for dealing with the threatening disaster situation or disaster as it may consider necessary
- j) Lay down broad policies and guidelines for the functioning of the National Institute of Disaster Management.

Powers and functions of National Executive Committee

The National Executive Committee may—

- a. Act as the coordinating and monitoring body for disaster management
- b. Prepare the National Plan to be approved by the National Authority
- c. Coordinate and monitor the implementation of the National Policy
- d. Lay down guidelines for preparing disaster management plans by different Ministries or Departments of the Government of India and the State Authorities
- e. Provide necessary technical assistance to the State Governments and the State Authorities for preparing their disaster management plans in accordance with the guidelines laid down by the National Authority
- f. Monitor the implementation of the National Plan and the plans prepared by the Ministries or Departments of the Government of India
- g. Monitor the implementation of the guidelines laid down by the National Authority for integrating of measures for prevention of disasters and mitigation by the Ministries or Departments in their development plans and projects
- h. Monitor, coordinate and give directions regarding the mitigation and preparedness measures to be taken by different Ministries or Departments and agencies of the Government
- i. Evaluate the preparedness at all governmental levels for the purpose of responding to any threatening disaster situation or disaster and give directions, where necessary, for enhancing such preparedness
- j. Plan and coordinate specialized training programme for disaster management for different levels of officers, employees and voluntary rescue workers
- k. Coordinate response in the event of any threatening disaster situation or disaster
- l. Lay down guidelines for, or give directions to, the concerned Ministries or Departments of the Government of India, the State

Governments and the State Authorities regarding measures to be taken by them in response to any threatening disaster situation or disaster

- m. Require any department or agency of the Government to make available to the National Authority or State Authorities such men or material resources as are available with it for the purposes of emergency response, rescue and relief
- n. Advise, assist and coordinate the activities of the Ministries or Departments of the Government of India, State Authorities, statutory bodies, other governmental or non-governmental organisations and others engaged in disaster management
- o. provide necessary technical assistance or give advice to the State Authorities and District Authorities for carrying out their functions under this Act
- p. Promote general education and awareness in relation to disaster management
- q. Perform such other functions as the National Authority may require it to perform.

National Plan

The National Plan shall be prepared by the National Executive Committee and approved by the National Authority.

- a) The National Plan shall include—
- b) Measures to be taken for the prevention of disasters, or the mitigation of their effects
- c) Measures to be taken for the integration of mitigation measures in the development plans
- d) Measures to be taken for preparedness and capacity building to effectively respond to any threatening disaster situations or disaster
- e) Roles and responsibilities of different Ministries or Departments of the Government of India in respect of measures specified in clauses (a), (b) and (c).
- f) The National Plan shall be reviewed and updated annually.
- g) Appropriate provisions shall be made by the Central Government for financing the measures to be carried out under the National Plan.
- h) Copies of the National Plan referred to the Ministries or Departments of the Government of India and such Ministries or Departments shall draw up their own plans in accordance with the National Plan

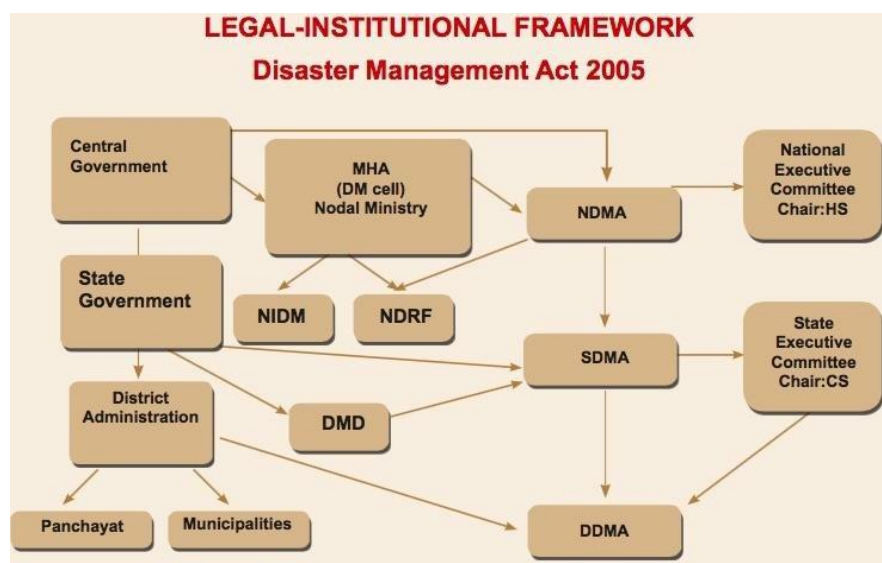
Guidelines for minimum standards of relief.—

The National Authority shall recommend guidelines for the minimum standards of relief to be provided to persons affected by disaster, which shall include,—

- (i) The minimum requirements to be provided in the relief camps in relation to shelter, food, drinking water, medical cover and sanitation;
- (ii) The special provisions to be made for widows and orphans;
- (iii) On account of loss of life as also assistance on account of damage to houses and for restoration of means of livelihood

INSTITUTIONAL PROCESSES AND FRAMEWORK

- India has been traditionally vulnerable to natural disasters on account of its unique Geo-Climatic conditions.
- Floods, Droughts, Cyclones are recurrent phenomenon.
- Development cannot be sustained unless disaster events are effectively managed
- The Disaster Management Act, 2005 deals with the management of disasters.
- This act has a three tier Disaster Management structure in India at National, States and District levels
- Under the act, the NDMA, SDMA, NEC, NDRF, NIDM and disaster related funds were established.
- Institutional structure for disaster management is hierarchical and functions at three levels – centre, state and district.
- It is a multi-stakeholder setup, i.e., the structure draws involvement of various relevant ministries, government departments and administrative bodies.



National Disaster Management Authority (NDMA)

- ✓ It consists of nine members with prime minister as a chairperson
- ✓ National Authority responsible for laying down the policies, plans and guidelines for disaster management and for ensuring timely and effective response to disaster.

National Executive Committee (NEC)

- ✓ NEC is responsible for assisting NDMA in execution of various functions for disaster management like Implementing the plans and policies of NDMA
- ✓ Ensuring compliance with the directives of Central Government
- ✓ To act as a coordinating and monitoring body for disaster management
- ✓ Prepare the National Plan to be approved by the NDMA
- ✓ Prepare guidelines for different ministries with respect to disaster management.

State Disaster Management Authority (SDMA)

- ✓ A state Disaster Management Authority is established by every state government.
- ✓ The Chief Minister of the state is the chairperson of SDMA.
- ✓ There are maximum 9 members

State Executive Committee (SEC)

- ✓ The state government also creates a State Executive Committee to assist the State Authority in the performance of its functions and to coordinate action in accordance with the guidelines laid down by the State Authority and ensure the compliance of directions issued by the national Authority.
- ✓ Its powers and functions are almost a replica of the NEC at state level.

District Disaster Management Authority

- It consists of Chairperson and seven members
- The collector or District Magistrate or Deputy Commissioner would be the chairman.
- The DDMA works as a district planning, coordinating and implementing body for disaster management.
- It will coordinate with the upper two tiers of the structure and will plan the implementation of the prevention, mitigation and preparedness at local level.

National Disaster Response Force

- For the purpose of specialist response to a threatening disaster situation or disaster.
- The general superintendence, direction and control of the Force shall be vested and exercised by NDMA.

National Disaster Response Fund

- For meeting any threatening disaster situation or disaster.
- The central government will be able to use the money from this fund to meet expenses for emergency response, relief and rehabilitation.

National Institute of Disaster Management

- It is responsible for planning and promoting training and research in the area of disaster management.
- It is a premier national organization working for human resource development at national level in the area of disaster management

Ineffectiveness in preparedness and coordination, lack of implementation capacity at state level, not constituting Disaster Mitigation Fund, inadequate technology and manpower remain as challenge in Disaster Management.

EARLY WARNING SYSTEM

It is defined as the set of capabilities needed to generate and disseminating timely and meaningful warning information of the possible extreme events or disaster.

Eg. Flood, drought, fire, earthquake..etc

Early warning information comes from different department

- Meteorological offices(for weather related disasters- flood, cyclone etc.)
- Ministries of Health (for example, disease outbreaks) and
- Agriculture (for example, crop forecasts)
- Local and indigenous sources
- Media sources and increasingly from Internet early warning services.

Elements of Early warning

1. Risk Knowledge
2. Monitoring and Predicting
3. Disseminating Information
4. Response

Risk Knowledge:

Risk assessment provides essential information to set priorities for mitigation and prevention strategies and designing early warning systems.

Monitoring and Predicting:

Systems with monitoring and predicting capabilities provide timely estimates of the potential risk faced by communities, economies and the environment.

Disseminating Information:

- ✓ Communication systems are needed for delivering warning messages to the affected locations to alert local and regional governmental agencies.
- ✓ The messages need to be reliable, simple to be understood by authorities and public.

Response:

- ✓ Coordination, good governance and appropriate action plans are a key point in effective early warning.
- ✓ Likewise, public awareness and education are critical aspects of disaster mitigation.

Types of early warning system

1. Communication of early warning information
2. Community Based Early Warning System

Communication of early warning information

- ✓ An effective early warning system needs an effective communication system.
- ✓ Early warning communication systems are made of two main components:
 - Communication infrastructure hardware that must be reliable and robust, especially during the natural disasters

- Appropriate and effective interactions among the main actors of the early warning process such as the scientific community, stakeholders, decision makers, the public, and the media.
- Many communication tools are currently available for warning dissemination such as Short Message Service (SMS) (cellular phone text messaging), email, radio, TV, and web service. Information and communication technology (ICT) is a key element in early warning.
- ICT plays an important role in disaster communication and dissemination of information to organizations in charge of responding to warnings and to the public during and after a disaster.

Community Based Early Warning System

- ✓ It is based on a "people-centered" approach that empowers individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner in a bid to reduce the possibility of personal injury, loss of life, damage to property, environment and loss of livelihood.
- ✓ It provides communities, practitioners and organizations involved in disaster risk management with advance information of risks that can be readily translated into prevention, preparedness and response actions.
- ✓ CBEWS helps to reduce economic losses

Benefits of Early warning systems:

- Reduction in loss of life
- Early notification of emergency system
- Reduced public stress

ADVISORIES FROM APPROPRIATE AGENCIES

- ✓ Disaster management needs a strong political commitment for erecting an effective planning and coordination process at the governmental and society levels.
- ✓ A structure with a clearly defined authority as well as an appropriate budget to maintain an effective disaster plan is needed, Preparedness plans should be comprehensive in scale and operation as disaster management planning is a sequential and continuous process.
- ✓ Effective planning requires systematic diagnosis, resource evaluation, and continuous feedback towards fulfillment of the goals of disaster reduction.

FRAMEWORK COORDINATION AT GOVERNMENT LEVEL

At central level

- At the central level, a National Crisis Management Committee, headed by the Cabinet Secretary, has been constituted with the nodal ministries in charge of various types of disasters and supporting ministries as members.
- The Central Relief Commissioner functions as the coordinator at the national level, under whom a Crisis Management Group (CMG) has been constituted.
- The CMG meets as often as required in the natural disasters to coordinate at the central level and also with the state governments as and when required.
- The Union Ministry of Home Affairs (MHA) acts as the nodal agency for disaster management.

i. **Droughts** – Ministry of agriculture

ii. **Epidemics and Biological Disasters** – Ministry of Health

iii. **Chemical or Industrial Chemical Disasters** – Ministry of Environment & Forest

iv. **Nuclear Accidents** – Department of Atomic Energy

v. **Railway Accidents** – Ministry of Railways

At state level

- The responsibility to cope with natural disasters is essentially that of the state government.
- The role of the central government is supportive.
- It supplements the physical and financial resources of the state governments.
- Most of the states have Relief Commissioners Secretaries who are in charge of the relief and rehabilitation measures in the wake of natural disasters in their states.
- The Chief Secretary is in overall charge of the relief operations in the state and the Relief Commissioner and the Additional Relief Commissioners function under his direction and control

At District Level

- The district administration is the focal point for the implementation of all government plans and activities.
- Considerable powers have been vested in the District Collector to carry out relief operations in the shortest possible time.
- In the event of shortage of funds, the Collector is also empowered to draw money from the district treasury under his emergency powers.

- The district administration is also required to prepare a contingency plan in advance depending on the type of disaster likely to affect the district
- The actual day-to-day functions of administering relief are the responsibility of the Collector/ District Magistrate/Deputy Commissioner who exercises co-ordinating and supervising powers over all departments at the district level.
- A district is divided into sub-divisions or 'tehsils' or 'talukas', While the head of the Sub-division is called the Sub-divisional Officer, the head of the 'tehsil' is generally known as Tehsildaar or Talukar in some states.
- At the block or circle level, there is the Block Development Officer or Circle Officer who looks after relief works,
- At the village level, the Village Level Worker remains in contact with the villages under his charge.

ROLE OF COMMUNITY PARTICIPATION

- Community-based Organisations or the CBOs are doing a lot of work in the area of disaster management
- The CBOs, it has been pointed out, perform certain pertinent functions.
 - ✓ They offer mutual support and solidarity
 - ✓ Strengthen people's ability to face crisis
 - ✓ Generate consciousness, awareness and analysis on issues of common concern
 - ✓ Enable people to demand an access to services and information offered by government agencies
 - ✓ Organise collective acquisition of skills and knowledge in various spheres
 - ✓ Orientation training in disaster preparedness for villagers and staff members
 - ✓ Discussion on disaster preparedness in general meetings
 - ✓ Sponsoring of staff for specialized training
 - ✓ Reparation of a handbook for emergencies

ROLE OF NON- GOVERNMENTAL ORGANISATIONS

- The Non-governmental Organisations (NGOs) are the most effective means of achieving an efficient communication link between the disaster management agencies and the affected community.
- In typical disaster situations, they could be of help in preparedness, relief and rescue, rehabilitation and reconstruction, and also in monitoring and feedback.

- If the potential of NGOs is utilised in the right earnest, they could act as the key to a successful and participatory approach to disaster management.

Interest Groups

- ✓ These are also NGOs, which are multi-purpose in nature having varied interests, such as the Rotary Club.
- ✓ However, such interest groups are very active, and have come forward to help disaster victims in the times of need.
- ✓ They could play a major role in resource mobilisation for relief aid and rehabilitation purposes.

Educational Institutions

- ✓ The educational institutions such as schools and colleges play an important role in disaster management.
- ✓ Their prime responsibility is to spread awareness on natural disasters, provide preventive action needed to minimise damage due to disasters as well as ensure immediate relief and rescue.
- ✓ Besides, these institutions have large buildings at local levels, which could be used as shelters for the victim in the times of disaster

Use of Mass Media and Social Media:

- ✓ Mass media plays a very important role in spreading awareness about disasters.
- ✓ Immediately after a major disaster in any part of the world, the curiosity and apprehension among the communities about their own risk is at its maximum.
- ✓ This is an opportune time to carry out public awareness campaigns and use media to focus on generating awareness about the risk the community is exposed
- ✓ This could best be achieved through a healthy partnership between the media and the disaster management machinery.
- ✓ An important input in such awareness generation programmes could be the lessons that have been learnt from disasters in the past or from those in other areas.
- ✓ For this purpose, the details of all such disasters need to be properly documented and kept in the public domain.

Police and Para-military Forces

- ✓ Police is always immediately mobilised to reach the site of disaster with a view to carry out, relief and rescue operations with the coordination agencies.

- ✓ It is also the responsibility of the police to provide security and maintain law and order at disaster locations where chances of chaos taking advantage of the situation are higher.
- ✓ Police personnel deployed for such relief operations could prevent commission of cognisable offences including all offences against life, property and public tranquility.
- ✓ The police communication system is made available for transmission and receipt of messages in connection with disasters.
- ✓ The police also regulate movement of victims, rescue and relief work, medical assistance and supplies.
- ✓ The role of para-military forces is very important, as they may be called upon for additional assistance to the police in situations requiring emergency attention.

Armed Forces

- ✓ The impact of disasters can be reduced only if there is coordination and cooperation from varied sections of the society
 - ✓ There is a need for a high degree of cooperation and coordination between the various agencies involved in disaster management at the time of a disaster.
 - ✓ Since many a time, the Armed Forces are required to provide assistance in the relief operations, it is essential that they are also involved in disaster planning and preparation
 - ✓ The role expected of them so that the procedure for deploying them is smooth and quick.
 - ✓ Their role in providing the emergency support functions such as communications, search and rescue operations, health and medical facilities, transportation, power, food and civil supplies, public works and engineering, information dissemination, and planning at the time of disasters is extremely beneficial.
- We cannot predict the disaster or hazards but we have to manage the crisis situation.
 - The system requires innovative thinking and fundamental changes in order to quicken the emergency responses of the administration and increase the effectiveness of the machinery to meet the crisis situation and enhance crisis preparedness.

UNIT-3

INTER-RELATIONSHIP BETWEEN DISASTER AND DEVELOPMENT

VULNERABILITY

It refers to the inability to withstand and recover from the impact of a natural or man-made hazard

Factors affecting vulnerability

- **Physical factors**

Poor design and construction of buildings, unregulated land use planning..etc

- **Social factors**

Poverty, marginalisation, discrimination by gender, social status, disability and age..etc

- **Economic factors**

Vulnerable rural livelihoods, dependence on single industries, globalisation of business and supply demands

- **Environmental factors**

Poor environmental management, over consumption of natural resources, climate change...etc

RELEVANCE OF INDIGENOUS KNOWLEDGE

- ✓ **Indigenous knowledge is the knowledge of resources that people in a given community have developed overtime, and continues to develop.**
- ✓ **It is based on the experience, often tested over centuries of use, adapted to local culture and environment, dynamic and changing.**
- ✓ People have an intimate knowledge of many aspects of their surroundings and their daily lives.
- ✓ Over centuries, people have learnt how to grow food and to survive in difficult environments.
- ✓ They know what varieties of crops to plant, when to sow and weed, which plants are poisonous, which can be used for control of diseases in plants, livestock and human beings.
- ✓ Indigenous knowledge is passed from generation to generation usually by word of mouth and cultural rituals, and has been the basis for agriculture, food preparation and conservation, health care, education, and a wide range of other activities that sustain a society and its environment in many parts of the world for many centuries

Indigenous Peoples

- Indigenous peoples are inheritors and practitioners of unique cultures and ways of relating to people and the environment.
- They have retained social, cultural, economic and political characteristics that are distinct from those of the dominant societies in which they live

Characteristics of indigenous knowledge

- Generated within communities
- Oral in nature
- Location and culture specific
- Concerns critical issues of human and animal life
- Dynamic based on innovation, adaptation and experimentation

INDIGENOUS KNOWLEDGE SYSTEMS IN DISASTER RISK REDUCTION

- ✓ This system have existed as part of human life from year to year and important as it has shaped how people interact with their environment .
- ✓ Indigenous knowledge disaster reduction can mainly be classified into 4 categories.

- 1. Technological**
- 2. Economical**
- 3. Social**
- 4. Cultural**

Technological

- Technology is used almost in every aspects of life.
- Traditional practices are more effective for the community than scientific practices
- Most of the communities have intimate knowledge about the quality of soil, plants and seeds that are resistant to drought to flood.
- Farmers who work in the marginal lands practices practices mixed cropping, inter-cropping techniques which reduces risk of poor harvest.
- In many places, houses are constructed on raised platform so that they remain above flood levels.
- Technologies can be used to while constructing earthquake resistance building or houses as well.

Economical

- Communities have developed their indigenous economic strategies to deal with the disasters.
- Usually vulnerable households try to store up grains, foods and cash which they can survive on difficult times.
- In case of food shortages, natural or wild foods from the forests can be used.
- Eg:-root, berries

Social

- This basically includes kinship networks, mutual aids and self help groups, sharing of foods, materials during the problems seen in many communities.
- People's joint participation to rebuilt or reconstruct the damaged infrastructure can be after disaster event

Cultural

- This includes religious beliefs and norms which helps the community in perceiving warning systems about the disaster and provide the medium to pass on the knowledge and experience from one generations to another generation
- Educational institutions can play an important role in disaster risk reduction and response by training a new generation of leaders, and by drawing on existing expertise.

Example: Indigenous survival strategies in Bangladesh

- In the event of natural disasters, the local people are usually the worst affected
- The concept of Community Based Disaster Risk Reduction (CBDRR) which attempts to help indigenous knowledge for disaster risk reduction and formulate strategies to mainstream the reduction of risk at the community level
- Among the South Asian countries, Bangladesh was the first to engage in CBDRR in the aftermath of the deadly Cyclone Bhola of 1970 which caused devastating storm surge flooding that resulted in a massive death toll of around 300,000 to 500,000 people
- Bangladesh with its low flat terrain and a climate heavily affected by monsoons.
- Naturally, people living in the flood-prone regions have, over time, devised several coping techniques for their survival.
- However much of this indigenous knowledge is increasingly being lost due to their non-documentation and spread of more modern and foreign technologies.

- Accordingly, the people living in flood-prone regions of Bangladesh have developed coping strategies and techniques through a process of innovation, experience and adaptation — based on their local environment and culture.

Disaster preparedness strategies

- The flood-prone communities prepare themselves well in advance of the monsoon seasons by storing food, clean water and animal fodder as these basic necessities are difficult to obtain in flood situations
- Emergency dry foods like Chira (rice) and molasses are wrapped in polythene and stored in earthen pots.
- Water purification tablets and portable ovens are also commonly used.
- Constant vigilance is kept, even at night to monitor the rise of the water level and rafts made of banana trunks are kept ready at hand. Sandbags, frozen cements, and bricks are also kept in readiness as defences against the spread of floods.
- the plinths of their houses are raised on bamboo poles above previously recorded flood levels

Alternative means of livelihood

- Alternative flood-resistant income generating activities like floating gardens and nurseries, fisheries in flood water and other small enterprises such as poultry farming.
- Floating gardens are an age-old practice of crop cultivation in areas where flood water remains for a prolonged period.
- local communities have developed a technique to construct floating platforms on which vegetables and other crops can be cultivated.
- Farmers use small boats to manage the floating agricultural land.

Community networks

- Community Based Organisations (CBOs) to help each other in many crisis situations including flood disasters by engaging in search and rescue activities and providing treatment to those affected.
- The volunteers also organise public dramas, folk songs, rallies and school-based campaigns to raise awareness about floods throughout the year.
- Often these CBOs are provided training in preparedness measures, capacity building and in providing first aid by government agencies.
- These agencies supply boats, life jackets and other equipment and organise community meetings to demonstrate mitigation techniques.
- These meetings are an effective tool for building a culture of safety; raising awareness and dissemination of early warning signals.

CLIMATE CHANGE ADAPTATION

Climate change (Global warming)

Climate change refers to a change in the climate that persists for decades or longer, arising from either natural causes or human activity

Definition for climate change adaptation

Climate adaptation is a process which helps individuals, communities and environment cope with a changing climate. It involves taking practical actions to manage risks from climate impacts, protect communities and strengthen the resilience of the economy

- An overwhelming scientific consensus maintains that climate change is due primarily to the human use of fossil fuels, which releases carbon dioxide and other greenhouse gases into the air.
- The gases trap heat within the atmosphere, which can have a range of effects on ecosystems, including rising sea levels, severe weather events, and droughts that render landscapes more susceptible to wildfires

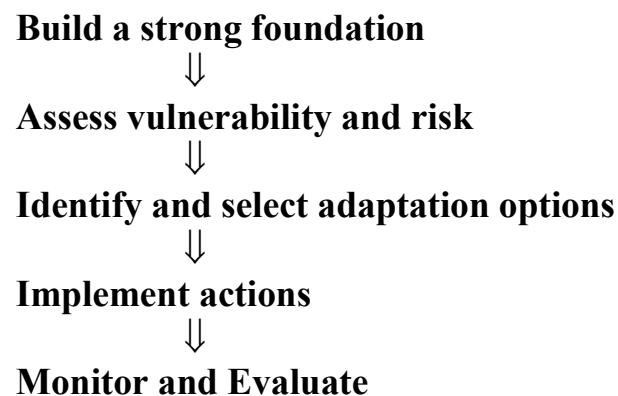
Causes of climate change

- Deforestation
- Volcanic eruption
- Greenhouse gas
- Industrial process

Effects of climate change

- Melting of glacier
- Changes in weather pattern
- Flood and drought problems
- Air pollution

Steps in climate change adaptation process



Build a strong foundation

- ✓ It includes internal and external supports, building teams of experts and advisors, scope, time for adaptation process
- ✓ The team should include one or more people to play a leadership role throughout the adaptation process
- ✓ Senior management greatly improves the success and provide strategic direction to the team as needed.

Assess vulnerability and risk

- ✓ Here the detailed assessment can take one month or year
- ✓ Discussion about the historical climate change trends and future climate projection
- ✓ Then identify the climate change impacts for each scenario
- ✓ The risk is assessed by determining likelihood and consequences for each impact
- ✓ Then they are classified as low risk, medium risk, high risk
- ✓ After the risk is assessed the vulnerabilities are prioritized

Identify and select adaptation options

- ✓ Identify the current and future adaptation actions, discussing the advantages and disadvantages of each approach
- ✓ Prioritize adaptation options based on effectiveness and possibilities
- ✓ Review the adaptation option and select the effective adaptation option

Implement actions

- ✓ Now the selected adaptation process is implemented
- ✓ Before implementing priority actions, it is essential to return to the question that started your adaptation process: “Do we have support to proceed at this time?” At the level of a specific action, the key question is, “What level of support is needed to implement this action?”

Monitor and Evaluate

- ✓ Prioritized options need to be evaluated against the broad spectrum of actions and priorities at the site level, and considered beyond their benefits for climate change adaptation.
- ✓ In some cases, options may not be supported by senior managers or key stakeholders, and additional actions or adjustments will need to be explored

MITIGATION

- ✓ Improving energy efficiency and option for renewable energy over fossil fuels.
- ✓ Promoting public transport and sustainable mobility by increasing the numbers of journeys in towns by bicycle, reducing the number of flights and taking more trips by train or in shared cars.
- ✓ Promoting ecological industry, agriculture, fishing and livestock farming, food sustainability, responsible consumption and the 3Rs rule (reduce, reuse, recycle).
- ✓ Erecting buildings and infrastructure that is safer and more sustainable.
- ✓ Replanting forests and restoring damaged ecosystems.
- ✓ Developing action plans for climate emergencies
- ✓ Investigating and developing innovative solutions to prevent and manage natural disaster

If the measures for mitigating and adapting to climate change are successful, by next decade — according to the World Economic Forum (WEF) — we could achieve day-to-day scenarios such as:

Mobility

- ✓ Most journeys will be made by train or shared electric car, equipped with algorithms that will select the best route in order to reduce consumption and maximise the number of passengers.
- ✓ In towns, we will choose to walk, travel by bike or use public transport in order to save time and improve our quality of life through a reduction in noise and in traffic jams.

Architecture and town planning

- ✓ We will live in houses fed by renewable energy and scarcely any concrete buildings will be built.
- ✓ There will be fewer parking zones in our streets and more urban allotments, parks and gardens

Five main steps that society needs to take to defeat climate change

1. Commitment
2. Participation
3. Healthy habit
4. Environmental awareness
5. Efficiency and innovation

IMPACT ON DEVELOPMENT PROJECT

Dam

- ✓ Dam, structure built across a stream, a river, to retain water.
- ✓ Dams are built to provide water for human consumption, for irrigating arid or for use in industrial processes.
- ✓ They are used to increase the amount of water available for generating hydroelectric power
- ✓ Dams can also provide a lake for recreational activities such as swimming, boating, and fishing.

Causes

- Overtopping
- Foundation defects
- Piping and seepage failures
- Conduit and valve failure
- Cracking
- Inadequate maintenance

Overtopping:

- ✓ These failures occur as a result of poor spillway design, leading to a reservoir filling too high with water, especially in times of heavy rainfall.
- ✓ Other causes of this type of failure include settling of the crest of the dam or spillway blockage.

Foundation defects:

- ✓ These failures occur as a result of settling in the foundation of the dam, instability of slopes surrounding the dam, uplift pressures, and seepage around the foundation.
- ✓ All of these failures result in structural instability and potential dam failure.

Piping and seepage failures:

- ✓ These failures occur as a result of internal erosion caused by seepage and erosion along hydraulic structures such as the spillways.
- ✓ As well, erosion as a result of animal burrows and cracks in the dam structure contribute to these failures.

Conduit and valve failure:

These failures occur as a result of problems with valves and conduits.

Cracking:

Cracking caused by movements like the natural settling of a dam

Inadequate maintenance:

without proper maintenance in dams cause failure in the structure

Impacts of dam

- Displacement of People
- Among physically displaced people officially recognized as project affected not all are given assistance to resettle in new locations.
- Loss of Livelihoods
- Blocking migration of aquatic organisms
- difficult in flood time
- Fear in mind of the people
- Many homes will be destroyed

Example: Kodaganar Dam

- Kodaganar dam, also known as Alagapuri dam an irrigation dam built on Kodaganar River, located in Alagapuri village, near Vedasandur, Dindugul District in Tamil Nadu state of India
- First built in 1977 the dam collapsed in 1979 flooding downstream due to multiple factors.
- The Dam was later fully reconstructed and reopened in 1994.
- Height is 12.75 metres (41.8 ft)

Dam failure

- Following heavy rains in the Kodaikanal range during 1978 in Western Ghats, flooding happened due to overtopping by flood waters.
- The waters which flowed over the downstream slopes of the embankment and breached the dam along various reaches
- In addition, there was an Earthquake registered during the period of failure although the foundation was strong. .
- Tough shutters were promptly operated during flood, the staff could only partially lift the shutters, due to power failure the additional stand-by generator commissioned did not help either
- The staff then opted for the manual operation of shutters. In spite of all efforts, water eventually overtopped the embankment.
- Water gushed over the rear slopes, as a cascade of water was eroding the slopes.
- Breaches of length 20 m to 200 m were observed.
- It appeared as if the entire dam was overtopped and breached.
- Flooding happened downstream and the dam then part of Madurai district and Tiruchirappalli district with many lives lost downstream mostly in present-day Aravakuruchi taluk.

EMBANKMENT

- ✓ An embankment refers to a volume of earthen material that is placed and compacted for the purpose of raising the grade of a roadway (or railway) above the level of the existing surrounding ground surface.
- ✓ A fill refers to a volume of earthen material that is placed and compacted for the purpose of filling in a hole or depression.
- ✓ Embankments or fills are constructed of materials that usually consist of soil, but may also include aggregate, rock, or crushed paving material

FAILURE OF EMBANKMENT

1. Hydraulic Failures
2. Seepage Failures
3. Structural Failures

Hydraulic failures

It may be related directly or indirectly to the following:

- **Overtopping**
- **Wave Erosion** - Notching of upstream face by wave action reduces the embankment cross section thickness and weakens embankment material.

Seepage Failures

- Seepage occurs through the earthen embankment or dike and/or through its foundation.
- Seepage, if uncontrolled, can erode fine soil material from the downstream slope or foundation and continue moving towards the cavity to the pond or lake often leading to a complete failure of the embankment.
- Seepage can also cause slope failures by saturating the slope material, thereby weakening the adhesive properties of the soil and its stability.
- Burrows or holes created by animals such as the groundhog or woodchuck, or muskrat create voids in the embankment or dike, which weaken the structure and may serve as a pathway for seepage.
- Tree roots can provide a smooth surface for seepage to travel along.

Structural Failures

- Structural failures involve the rupture of the embankment material and/or its foundation.
- Structural failure of an earthen embankment may take on the form of a slide or displacement of material in either the downstream or upstream face.
- Cracks or other irregularities in the embankment or dike generally are signs of serious instability and may indicate structural failure.

Impacts of embankment

- Unable to withstand erosion
- They have a higher maintenance cost as they are prone to erosion
- If breached, water will penetrate through the embankments
- Reduction in land

LAND USE

land use is the exploitation of land for agricultural, industrial, residential, recreational, or other purposes

Impacts

- Destruction of wildlife habitat
- Conversion of farmland and forests to urban development reduces the amount of lands available for food and timber production
- Deforestation reduce the quality of land resources
- Urban development causes air pollution, water pollution
- Soil erosion

What is appropriate technology?

- Appropriate technology is small-scale technology.
- It is simple enough that people can manage it directly and on a local level.
- Appropriate technology makes use of skills and technology that are available in a local community to supply basic human needs, such as gas and electricity, water, food, and waste disposal.

The following are the criteria for appropriate technology

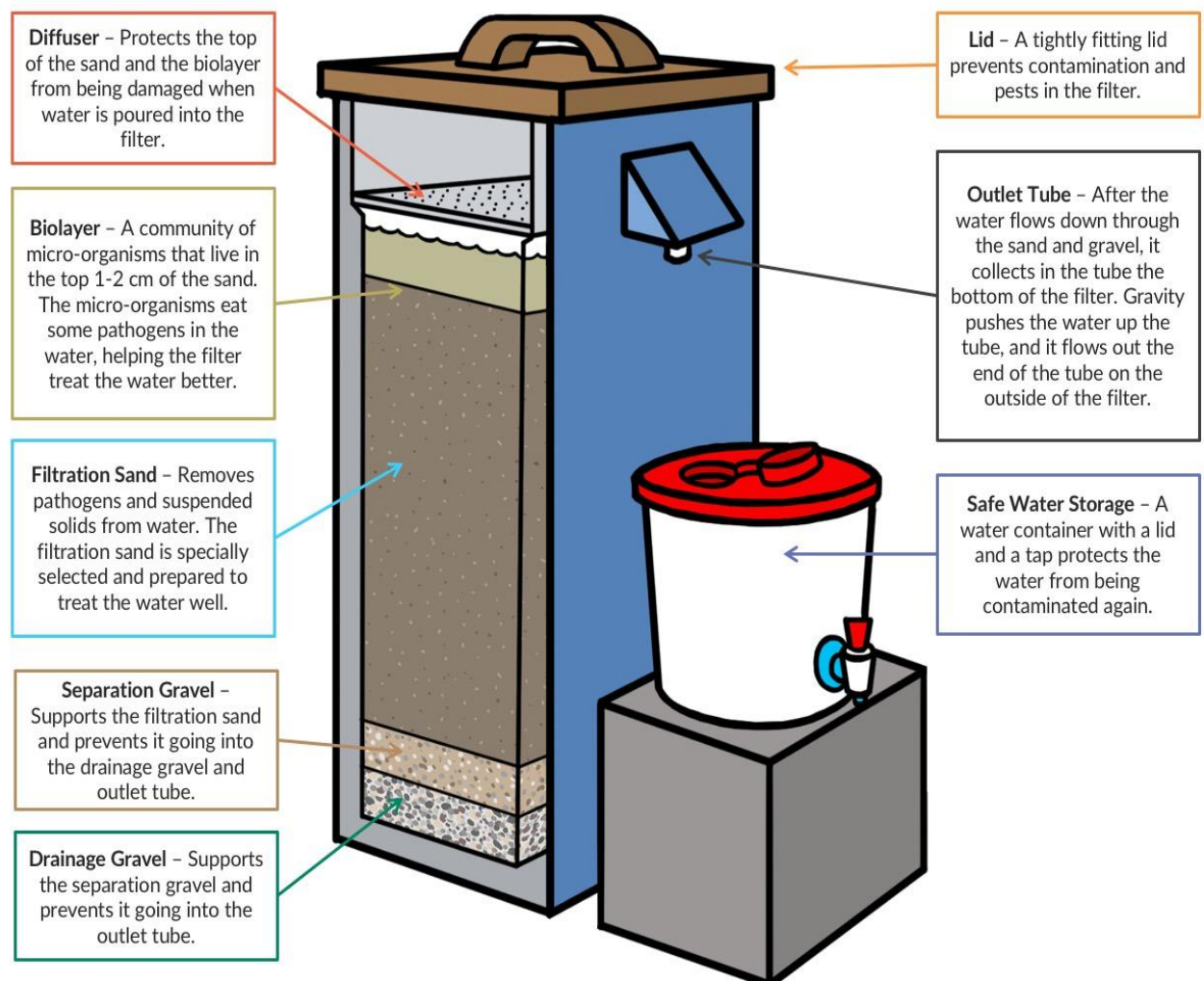
1. Create jobs where people live
2. Affordable enough for common use
3. Required simple tools and techniques

4. Used local material
5. Made things for local use

BIO SAND FILTER

Introduction

- The household biosand filter was proposed by Dr. David Manz in the late 1980s at the University of Calgary, Canada
- The system was developed from the slow sand filter, a technology that has been used for drinking water purification since the 1800s.
- Initial lab and field tests were conducted in 1991; the system was patented in 1993 and was implemented in the field in Nicaragua.

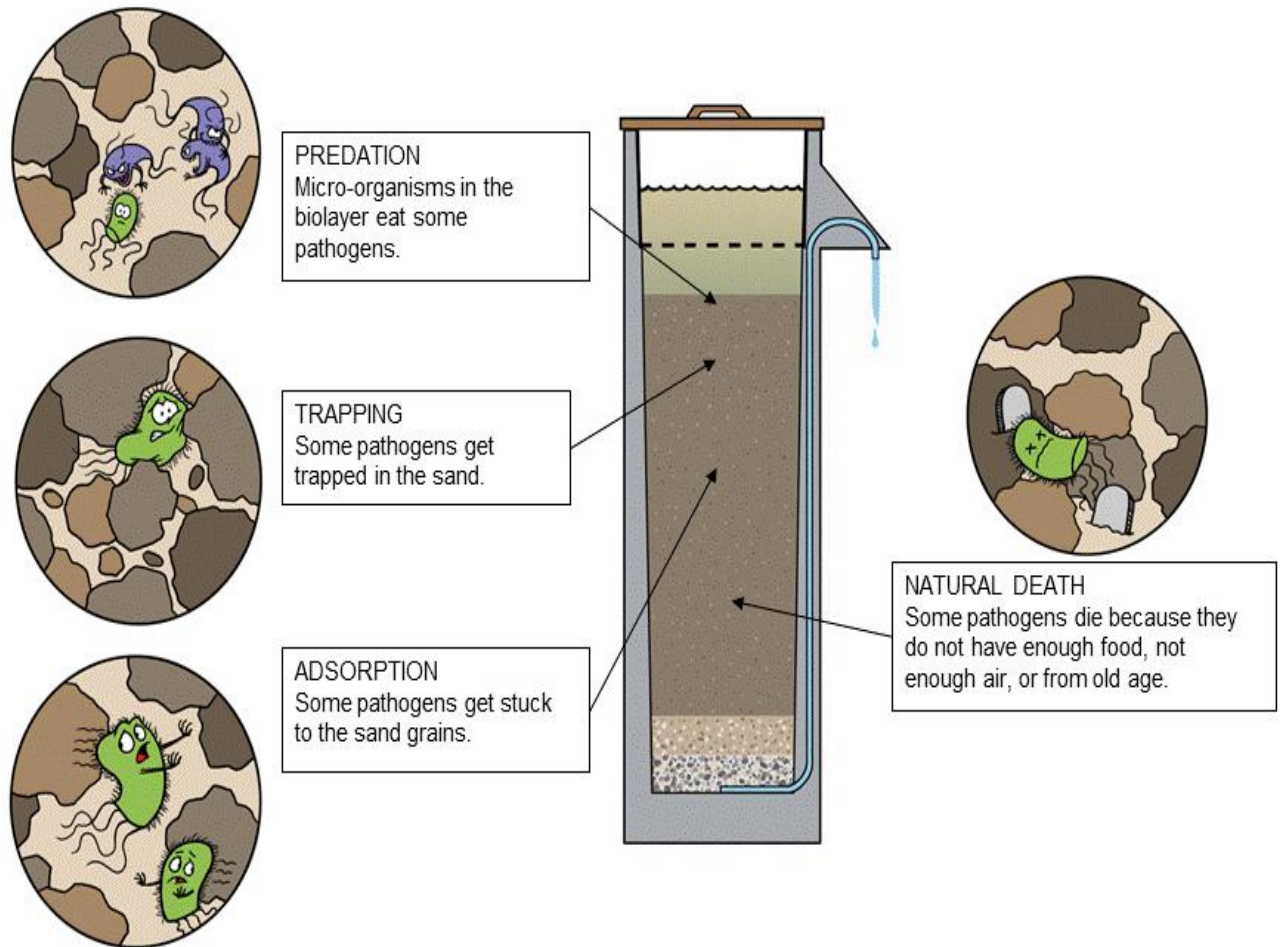


Operation

- The filter container can be made of concrete, plastic or any other water-proof, rustproof and non-toxic material.
- The concrete filter box is cast from a steel mould or made with a pre-fabricated pipe.
- The container is filled with layers of sieved and washed sand and gravel, also referred to as filter media.
- There is a standing water height of 5 cm above the sand layer, which is maintained by adjusting the height of the outlet pipe

Working

- Water is poured onto the top of the filter as needed
- Then the water will travel slowly through the sand and gravel bed
- At the base of the filter the water is collected in a pipe and is drained through plastic piping out of the filter for be collected and stored in a clean water container.
- Concrete filters have the outlet pipe embedded in the concrete, protecting it against breaks and leaks
- The treated water should be collected by the user in a safe storage container placed on a block or stand, so that the container opening is just under the outlet, minimising the risk for recontamination
- Pathogens and suspended solids are removed through a combination of biological and physical processes that take place in the biofilm layer and within the sand layer.
- The biosand Filter is a proven technology, which removes pathogens such as bacteria, protozoa and helminth.
- BSFs are also somewhat effective for the removal of virus.
- Physical parameters such as turbidity and iron are also eliminated from drinking water.
- However, dissolved chemicals (such as organic pesticides or arsenic) are not removed
- The treated water generally has an agreeable colour, taste and odour.



Advantages

- ✓ High removal of pathogens
- ✓ Removal of turbidity, colour, odour and iron (water tastes and looks good)
- ✓ Long life
- ✓ Can be fabricated from locally available materials generating an opportunity for local businesses
- ✓ Easy to operate and maintain

Disadvantages

- ✓ High turbidity will cause filter to clog and requires more maintenance
- ✓ Requires that the filter be used on a regular basis
- ✓ Cannot remove dissolved compounds
- ✓ Cannot move or transport

VULNERABILITY ANALYSIS

DEFINITION OF VULNERABILITY ASSESSMENT

Vulnerability assessments are systematic examinations of building elements, facilities, population groups or components of the economic, environment to identify features that are susceptible to damage from the effects of natural hazards.

Steps for vulnerability analysis

- Hazard Identification
- Hazard Analysis
- Critical Facilities Analysis
- Societal Analysis
- Economic Analysis
- Environmental Analysis
- Mitigation Opportunities Analysis

Hazard Identification

Hazard identification refers to the systematic use of all available information to determine which types of hazards might affect a community, along with their driving forces and typical effects.

Hazard Analysis

- Evaluating risks and vulnerabilities, especially to critical infrastructure and key resources
- Some of the Basic Terminology for Hazard Analysis such as

Severity

- ✓ Severity is a measure of the seriousness of the effects of a hazard event.
- ✓ It can be measured by the number of people affected, amount of capital lost, number of buildings uninhabitable, and other factors.
- ✓ Certain systems may be inoperable and infrastructure could be destroyed.

Magnitude

- ✓ Magnitude is a measure of the strength of a hazard event.

- ✓ The magnitude of a hazard is usually determined using technical measures specific to the hazard

Critical Facilities Analysis

- ✓ Critical infrastructure and key resources (CIKR) are those systems and assets so vital to the community that their incapacity or destruction would have a debilitating impact on public services, security, economics, public health, or safety, or any combination of those matters.
- ✓ Critical infrastructure and key resources require special planning because they are necessary for the health and welfare of the whole population, and/or they represent high potential for loss or damaging effects on the community.
- ✓ Some examples of critical infrastructure and key resources are listed below.
 - Hospitals/medical centers/nursing homes
 - Police and fire stations (public safety)
 - Emergency Operations Centers (EOCs)
 - Evacuation shelters
 - Schools
 - Nuclear power plants
 - Dams and bridges

Societal Analysis

- ✓ Social impacts of hazard exposure often fall disproportionately on the most vulnerable people in a society – the poor, minorities, children, the elderly, and the disabled.
- ✓ These groups often have the fewest resources to prepare for a flood, live in the highest-risk locations

Economic Analysis

- ✓ Interacting with the hazard itself and the exposure of populations and physical assets, are considered to be critical determinants of the resulting disaster damages and losses.
- ✓ Therefore, after the disaster how much economic losses have been occurred

Environmental vulnerability

- ✓ Environmental vulnerability is related to the risk of damage to the natural environment
- ✓ This involves the analysis, evaluation and presentation of data and information on:
- ✓ The mechanisms and magnitude with which global change affects natural and human systems, and
- ✓ Responses and interactions of these systems that reduce their exposure and enhance their adaptive capacity to global change

Mitigation Opportunities Analysis

- Implementing new policies by government
- Developing new strategies
- Afforestation
- Using satellite, observing system to monitor the climate change
- Proper communication should be maintained
- Using electronic vehicles that helps to reduce the pollution in atmosphere
- Use solar panels

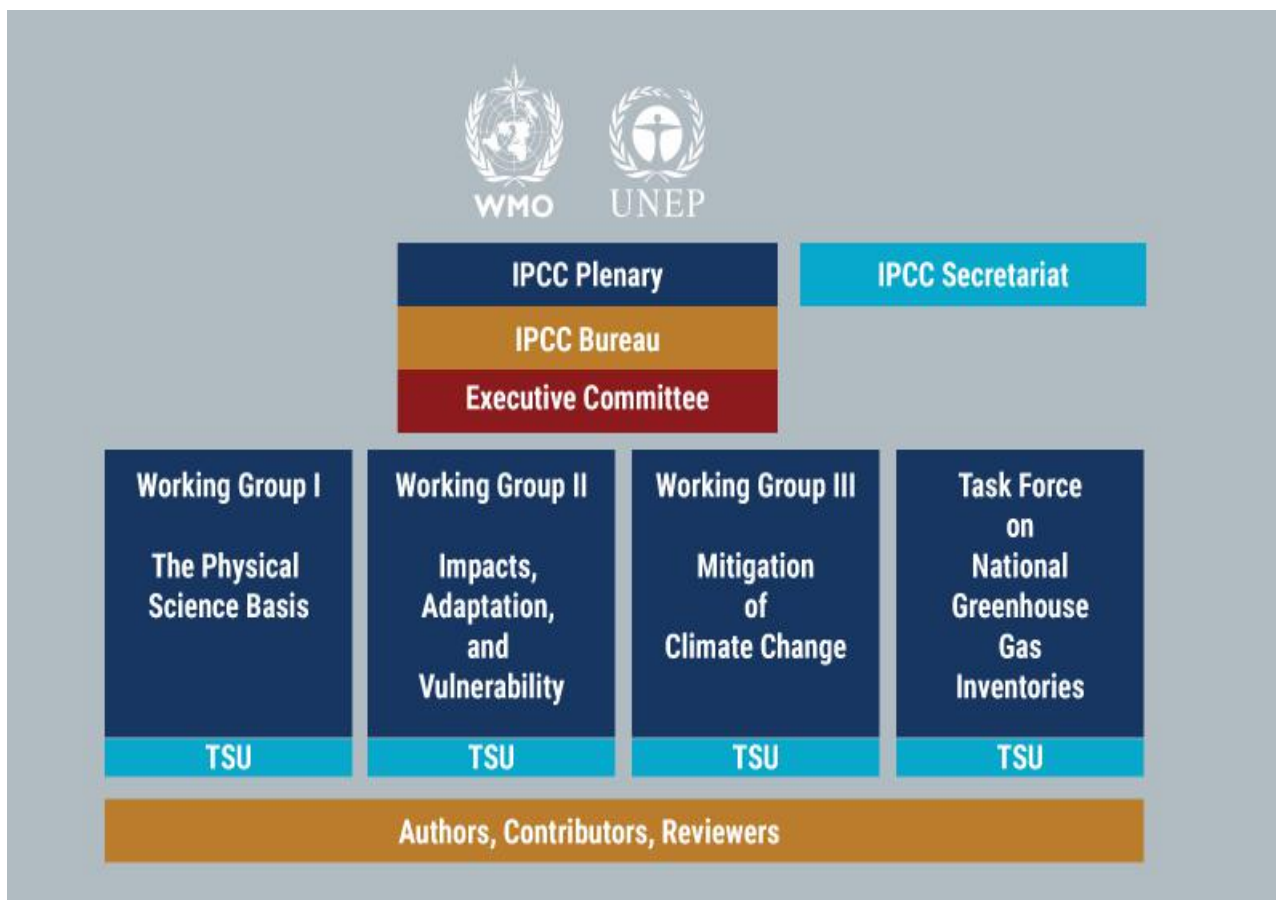
IPCC-INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

- The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change
- The IPCC provides regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation

HISTORY

- ✓ Created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP)
- ✓ The IPCC is an organization of governments that are members of the United Nations
- ✓ The IPCC currently has 195 members.
- ✓ Thousands of people from all over the world contribute to the work of the IPCC.

- ✓ Since 1988, the IPCC has had five assessment cycles and delivered five Assessment Reports, the most comprehensive scientific reports about climate change produced worldwide.
- ✓ It has also produced a range of Methodology Reports, Special Reports and Technical Papers
- ✓ For the assessment reports, IPCC scientists volunteer their time to assess the thousands of scientific papers published each year to provide a comprehensive summary of what is known about the climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks.
- ✓ An open and transparent review by experts and governments around the world is an essential part of the IPCC process, to ensure an objective and complete assessment and to reflect a diverse range of views and expertise.
- ✓ Through its assessments, the IPCC identifies the strength of scientific agreement in different areas and indicates where further research is needed.



The Panel and the Plenary Sessions

- ✓ Representatives of IPCC member governments meet in Plenary Sessions at least once a year.
- ✓ The Sessions are attended by hundreds of officials and experts from relevant ministries, agencies and research institutions from member countries and from Observer Organizations.
- ✓ The Panel works by consensus to decide on the organization's budget and work programme; the scope and outline of its reports; issues related to principles and procedures of the IPCC..etc

The IPCC Bureau

The Panel elects a Bureau to provide guidance to the Panel on the scientific and technical aspects of its work, advise on related management and strategic issues, and take decisions on specific issues within its mandate

The Executive Committee

The ExCom's role is to strengthen and facilitate the timely and effective implementation of the IPCC work programme in accordance with the IPCC's Principles and Procedures, the decisions of the Panel, and the advice of the Bureau.

IPCC Authors and Review Editors

- ✓ Authors are selected on the basis of their expertise following a call to governments, Observer Organizations and the IPCC Bureau for nominations and the submission of detailed CVs
- ✓ Authors prepare the reports

Expert Reviewers

- ✓ Each report undergoes two review periods: an Expert Review of the First Order Draft, and a Government and Expert Review of the Second Order Draft.
- ✓ This review process includes wide participation, with hundreds of reviewers commenting on the accuracy and completeness of the scientific assessment contained in the drafts.

The Secretariat

- ✓ The Secretariat coordinates and assists the work of the Intergovernmental Panel on Climate Change.
- ✓ It organizes IPCC Plenary, Bureau and Executive Committee meetings and provides administrative support for these, including the preparation of documents and reports.
- ✓ It supports, as required, the Working Groups, the Task Force on National Greenhouse Gas Inventories, and any other task force, task group or committee established by the IPCC in the organization of their activities and meetings.
- ✓ The Secretariat also manages the IPCC Trust Fund and any other Funds agreed by the Panel, including budgeting, contributions to the IPCC Trust Fund, management of expenditure, auditing and reporting..etc

Technical Support Units (TSU)

- ✓ The TSUs provide scientific, technical and organizational support and support the Co-Chairs and Bureaux in the preparation and production of all relevant IPCC products.
- ✓ A TSU may also be formed to support the preparation of a Synthesis Report

Working Group I The Physical Science Basis

The IPCC Working Group I (WGI) examines the physical science underpinning past, present, and future climate change.

Working Group II- Impacts, Adaptation and Vulnerability

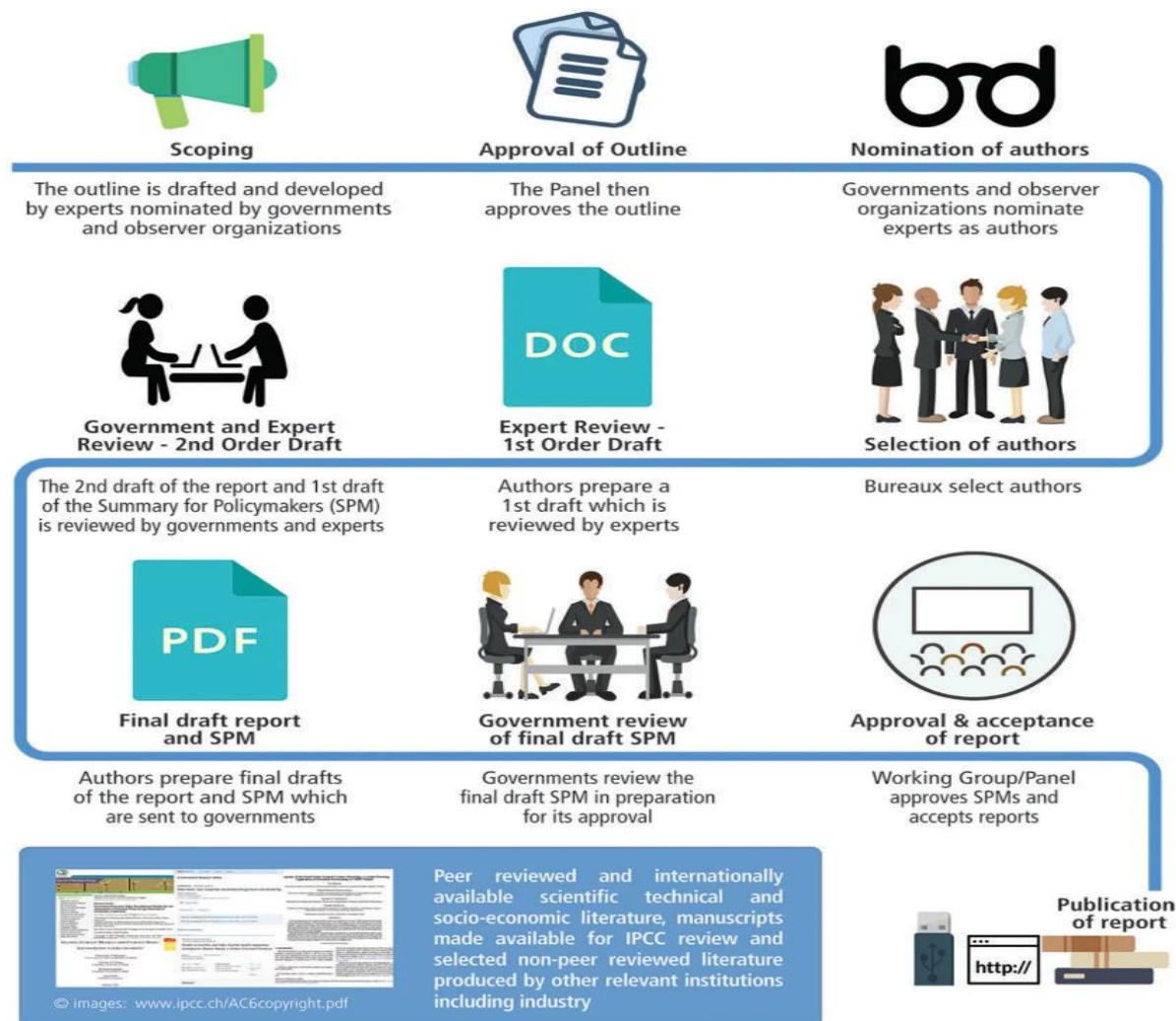
Working Group II assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change and options for adapting to it.

Working Group III -Mitigation of Climate Change

WG III focuses on climate change mitigation, assessing methods for reducing greenhouse gas emissions, and removing greenhouse gases from the atmosphere.

The Task Force on National Greenhouse Gas Inventories (TFI)

The TFI develops and refines an internationally-agreed methodology and software for the calculation and reporting of national GHG emissions and removals and encourages the use of this methodology by countries participating in the IPCC and by signatories of the United Nations Framework Convention on Climate Change (UNFCCC).



What IPCC says about India scenarios

- It projects a fall in crop yields and rise in the impact of extreme weather events in India
- The IPCC synthesis report, released on November 1, outlines the effects of climate change on all regions of the world.

- The following are the implications of climate change specifically for India , with observations from the synthesis report and the draft IPCC Assessment Report (AR5)

Effects of climate change on weather

- The largest chunk of the IPCC synthesis report focuses on the changes in weather patterns and projections related to extreme weather events.
- These changes are expected to have a cascading effect on the health of the economy as well as that of the people.
- ✓ Net annual temperatures in India in 2030s, with respect to 1970s, will increase from 1.7-2.2°C.
- ✓ Extreme temperatures are expected to increase by 1-4°C, with maximum increase in coastal regions.
- ✓ Mean and extreme precipitation during the Indian summer monsoon is expected to increase.

Extreme weather events: cyclones, floods and droughts

- People living in districts along the eastern coast of India are expected to be especially vulnerable to the impact of extreme weather events because of poor infrastructure and demographic development.
- Floods and droughts are likely to increase in India since there will be a decline in seasonal rainfall, coupled with increase in extreme precipitation during monsoon
- Delhi is one of the world's 2nd most populated cities that are located in areas with high risk of floods.
- Projections indicate that the frequency of cyclones is likely to decrease in 2030s, with increase in cyclonic intensity.

Agriculture, forests and trade

- Climate change will especially affect the livelihoods of people.
- Agriculture, the mainstay of the Indian economy, will see dramatic changes in yields, affecting people's right to food security.

- ✓ In India, the estimated countrywide agricultural loss in 2030 is over \$7 billion.
- ✓ It will severely affect the income of 10 per cent of the population.
- ✓ Monsoon sorghum grain yield is projected to decline by 2-14 per cent by 2020, with worsening yields by 2050 and 2080.
- ✓ A third of forest areas in India are projected to change by 2100, with deciduous forests changing into evergreen ones due to increased precipitation.
- ✓ Human pressures are, however, expected to slow these changes.
- ✓ Transport emissions are growing much faster than the value of trade, leading to a further increase in greenhouse gas emissions.

Health

Pollution-induced changes in air and water quality, as well as changing weather patterns, are expected to have wide-reaching effects on the health of Indians, according to the report.

- In addition to flood deaths, contamination of urban flood waters will increase the risk of water-borne diseases.
- Mental disorders and post traumatic stress syndrome have also been seen in extreme weather events and disaster-prone areas.
- High temperatures are associated with mortality rates in India and heat waves will especially affect outdoor workers.
- Air pollution in combination with increased temperatures will also affect the health of people.

Adaptation

Based on extensive research, the report recommends mitigation measures to conserve agriculture, water supply and air quality.

- Agricultural losses could be reduced by 80 per cent if cost-effective climate resilience measures are implemented.
- Policies to increase public transportation, promote walking and cycling, and reduce private cars will increase air quality and decrease the health burden, particularly in urban environments.

Examples of climate change impacts

- 1.1 to 3.2 billion people will experience increased water scarcity by 2080
- 20-30% of species could be at risk of extinction if increases in warming $>1.5-2.5^{\circ}\text{C}$

UNIT-4

DISASTER RISK MANAGEMENT IN INDIA

HAZARD PROFILE OF INDIA

- India is prone to disasters due to a number of factors; both natural and human-induced, including adverse geo-climatic conditions, topographic features, environmental degradation, population growth, urbanization, industrialization, non-scientific development practices etc.
- Various hazards to which India is prone to can be broadly divided into three categories viz. **Hydrological and climate related; Geological and Technological hazards**

Hydrological and Climate related Hazards

Floods

- ✓ Floods can be caused by heavy rainfall, inadequate capacity of rivers to carry the high flood discharge, inadequate drainage to carry away the rainwater quickly to streams/ rivers.
- ✓ Landslides blocking streams, etc.
- ✓ Further, flash floods occur because of high rate of water flow particularly in areas with less permeability of soil.
- ✓ Over 40 million hectare of landmass in India is prone to floods.
- ✓ Nearly 75% of the total annual rainfall is concentrated over a short south-west monsoon season of three to four months from June to September.
- ✓ As a result there is a very heavy discharge from the rivers during this period causing widespread floods.
- ✓ Flood problem is chronic in at least 10 states
- ✓ From October to December each year, a very large area of South India, including Tamil Nadu, the coastal regions of Andhra Pradesh and the union territory of Puducherry, receives up to 30 % of its annual rainfall from the northeast monsoon (or winter monsoon).
- ✓ These have caused devastating floods in Chennai in 2015.
- ✓ Most devastating floods in recent times have been the June 2013 Assam floods, 2013 Uttarakhand Floods, 2012 Brahmaputra Floods etc.

Cyclones

- ✓ India has a very long coastline which is exposed to tropical cyclones arising in the Bay of Bengal and Arabian Sea.
- ✓ Indian Ocean is one of the six major cyclone-prone regions in the world.

- ✓ In India cyclones occur usually in April-May, and also between October and December.
- ✓ The Eastern coastline is more prone to cyclones as about 80 % of total cyclones generated in the region hit there.
- ✓ The worst hitting cyclones have been the Andhra Pradesh cyclone of November 1977 and the super cyclone of Odisha in the year 1999.
- ✓ The impact of the cyclones is mainly confined to the coastal districts, the maximum destruction being within 100 Km from the centre of the cyclones and on either side of the storm track.
- ✓ The principal dangers from a cyclone include the strong winds; torrential rain and high tidal waves
- ✓ Most casualties are caused by coastal inundation by tidal waves and storm surges.

Heat Waves, Cold waves

- ✓ Heat waves refer to the extreme positive departure from the maximum temperature in summers.
- ✓ The fatalities caused by heat waves have increased in recent decades.
- ✓ The problem of heat wave is compounded by a decrease in diurnal temperature Range (DTR).
- ✓ In urban areas, the heat wave is increasing gaining notoriety for more and more fatalities.
- ✓ Cold waves occur mainly due to the extreme low temperature coupled with incursion of dry cold winds from north-west.
- ✓ Most affected areas of country due to the cold waves include the western and north-western regions and also Bihar, UP directly affected by the western disturbances.
- ✓ Heat wave in chennai may 2020 (42°C)
- ✓ 2017 North Indian cold wave (-12.4 °C)

Droughts

- ✓ Drought refers to the situation of less moisture in the soil (which makes the land unproductive) and scarcity of water for drinking, irrigation, industrial uses and other purposes, usually caused by deficient/less than average rainfall over a long period of time.
- ✓ Some states of India feature the perennial drought such as Rajasthan, Odisha, Gujarat, Madhya Pradesh etc.
- ✓ 16% of the country's total area is drought-prone and approximately 50 million people are affected annually by droughts.
- ✓ In India about 68 % of net sown area in the country is drought-prone.
- ✓ Most of the drought-prone areas identified by the Government of India lie in arid, semi-arid and sub-humid areas of the country.

- ✓ In the arid and semi-arid zones, very severe droughts occur once in every eight to nine years.
- ✓ The 1899 famine, in which over 4.5 million died.

Geological Disasters

Earthquakes

- ✓ Earthquake is almost impossible to be predicted, so it is the most destructive of all natural disasters.
- ✓ It is almost impossible to make arrangements and preparations against damages and collapses of buildings and other man-made structures hit by an earthquake.
- ✓ More than half of India's total area is vulnerable to seismic activity of varying intensities.
 - **BIHAR**
 - Magnitude: 8.1
 - Date: January 15, 1934
 - Toll: Over 30,000
 - **GUJARAT**
 - Magnitude: 7.7
 - Date: January 26, 2001
 - Toll: Over 20,000

Tsunami

- ✓ Tsunami refers to the displacement of a large volume of a body of water such as Ocean.
- ✓ Most Tsunamis are seismically generated, result of abrupt deformation of sea floor resulting vertical displacement of the overlying water.
- ✓ The Tsunami waves are small in amplitude and long wavelength (often hundred of kilometers long).
- ✓ The east and west coasts of India and the island regions are likely to be affected by Tsunamis generated mainly by subduction zone related earthquakes from the two potential source regions, viz. the Andaman-Nicobar-Sumatra Island Arc and the Makran subduction zone north of Arabian Sea.

Landslides

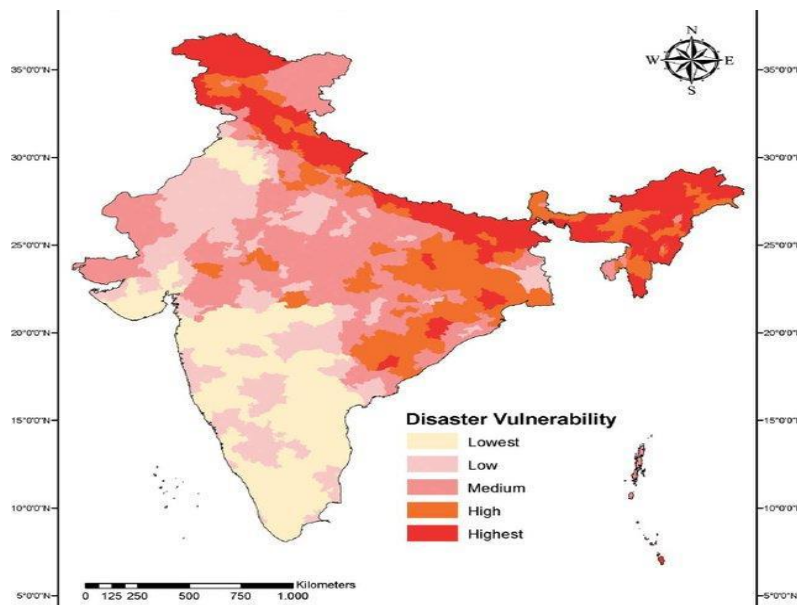
- ✓ Landslides are common in India in Himalayan region as well as Western Ghats.
- ✓ The Himalayan ranges are among the youngest fold mountains of world.
- ✓ They comprise a series of seven curvilinear parallel folds running along a grand arc of around 3400 kilometers.

- ✓ The landslides in this region are probably more frequent than any other areas in the world.
- ✓ The Western Ghats, particularly Nilgiri hills also are notorious for frequent landslides.
- ✓ 2014 Malin landslide / 1998 Malpa landslide

Technologic Disasters

Industrial, Chemical & Nuclear Disasters

- ✓ The industrial and chemical disasters can occur due to accident, negligence or incompetence.
- ✓ They may result in huge loss to lives and property.
- ✓ The Hazardous industries and the workers in these industries are particularly vulnerable to chemical and industrial disasters.
- ✓ The most significant chemical accidents in recorded history was the 1984 Bhopal Gas disaster, in which more than 3,800 people were killed after a highly toxic vapour, (methyl isocyanate), was released at a Union Carbide pesticides factory.
- ✓ Vishakapatnam gas leak is caused by leakage of styrene on 7 May 2020 -11 dead



VULNERABILITY PROFILE OF INDIA

- ✓ India is vulnerable, in varying degrees, to a large number of disasters.
- ✓ Around 59% of the landmass is prone to earthquakes of moderate to very high intensity.
- ✓ About 12% (over 40 million hectares) of its land is prone to floods and river erosion.

- ✓ Close to 5,700 km, out of the 7,516 km long coastline is prone to cyclones and tsunamis.
- ✓ 68% of its cultivable area is vulnerable to droughts; and, the hilly areas are at risk from landslides and avalanches.
- ✓ Moreover, India is also vulnerable to chemical, biological, radiological and nuclear (CBRN) emergencies and other man-made disasters
- ✓ Disaster risks in India are further compounded by increasing vulnerabilities related to changing demographics and socio-economic conditions, unplanned urbanization, development within high-risk zones, environmental degradation, climate change, geological hazards, epidemics and pandemics.
- ✓ Clearly, all these contribute to a situation where disasters seriously threaten India's economy, its population and sustainable development.

Worst Disasters in India

- ✓ Kashmir Floods (2014) affected Srinagar, Bandipur, Rajouri etc. areas of J&K have resulted into death of more than 500 people.
- ✓ Uttarkhand Flash Floods (2013) affected Govindghat, Kedar Dome, Rudraprayag district of Uttarakhand and resulted into death of more than 5,000 people.
- ✓ The Indian Ocean Tsunami (2004) affected parts of southern India and Andaman Nicobar Islands, Sri Lanka, Indonesia etc., and resulted in the death of more than 2 lakh people.
- ✓ Gujarat Earthquake (2001) affected Bhuj, Ahmedabad, Gandhinagar, Kutch, Surat, Rajkot district, Jamnagar and Jodia districts of Gujarat and resulted in death of more than 20,000 people.
- ✓ Odisha Super Cyclone or Paradip cyclone (1999) affected the coastal districts of Bhadrak, Balasore, Ganjam etc., and resulted into death of more than 10,000 people.
- ✓ The Great Famine (1876-1878) affected Madras, Mysore, Hyderabad, and Bombay and resulted into death of around 3 crore people.

Disaster relief

Disaster relief (or emergency management) refers to the process of responding to a disaster situation, providing humanitarian aid to persons and communities who have suffered from some form of disaster.

- It involves dealing with and avoiding risks and preparing, supporting, and rebuilding society when natural or human-made disasters occur.
- Components of disaster relief
- Communities affected by a disaster often require immediate relief such as shelter, protection and security , food and water and financial assistance (cash)
- To deliver effective relief measures, a collaborative effort requiring coordination between the community, government must occur

Food

- Food supplies are frequently part of to response to emergencies
- It is essential in each situation to first establish that food supply is correct response and then the composition is defined
- It is necessary to ensure the food donations are culturally and nutritionally appropriate for the affected populations and the cost of their purchase, transportation, storage and distribution is kept to a minimum

Shelter

- Shelter is very important for the survival in the initial stage of a disaster
- Beyond survival, shelter is necessary for security and personal safety, protection from the elements and resistance to ill health and disease
- Shelter assistance is provided to the individual households for the repair or construction of dwellings or the settlement of displaced households within existing accommodation or communities
- When it is not possible to provide individual shelter, collective shelter is provided in suitable large public buildings or structures such as halls or temporary planned or self settled camps

Sanitation

- Emergency disaster can occur anywhere in the world, affecting human health, peoples lives and the infrastructure build to support them
- Environmental health problems arising from effects on the physical, biological, social environment that threatens the human health
- Water supply, sanitation and human health are closely related

- Poor hygiene , inadequate quantities and quality of drinking water and lack of sanitation facilities cause millions of world's poorest people to die from preventable diseases

Waste management

- Any waste other than human excreta, urine and waste water is called solid waste
- Solid waste in rural areas generally include house sweeping, kitchen, garden waste, cattle dung, broken glass, metal, waste paper, plastic, cloth, markets and shopping areas,hotels..etc
- Solid waste is classified into 2 ways
 - 1. Biodegradable waste**
 - a) Aerobic decomposition (with oxygen)
 - b) Anaerobic decomposition (without oxygen)

2. Non-biodegradable waste

- a)Recyclable-Eg- plastic, paper, old cloth..etc
- b)Non-recyclable-Eg- thermocoal..etc

Health

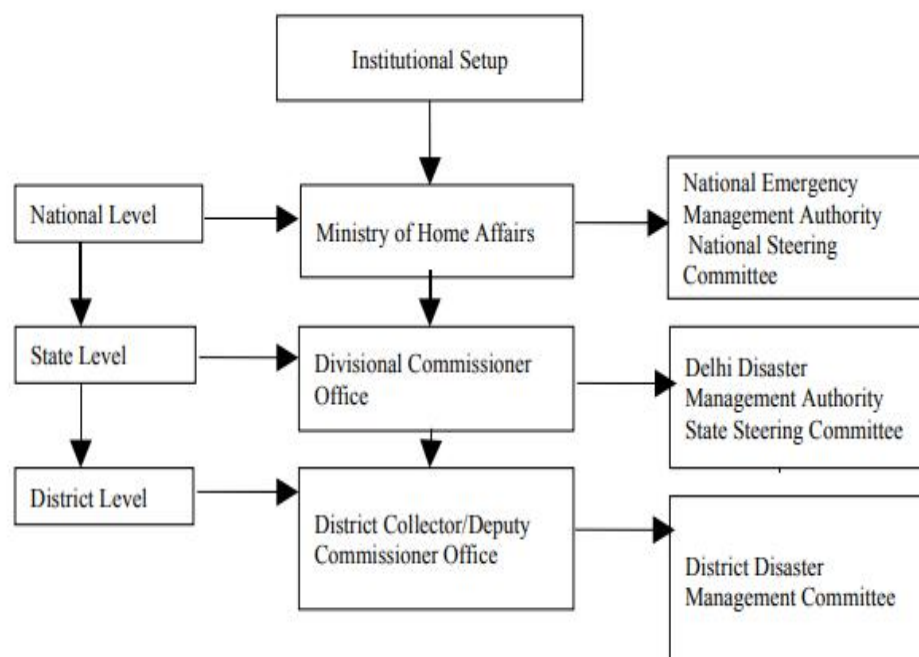
- Disasters and other emergencies often result in significant impacts on peoples health, including the loss of many lives
- Every new threat reveals the challenges for managing health risk and effects of emergencies and disasters
- Death, injuries, diseases, disabilities, psychosocial problems and other health impacts can be avoided or reduced by disaster risk management measures involving health
- Hospitals are required to have disaster plans and to practice for events such as mass casualty situations
- Hospitals may be damaged or destroyed by disaster and access to health care facilities may be cutoff physicians, nurses may not be available to get the work or areas to the injured persons

Some of the factors influencing health

- Overcrowding and poor shelter
- Poor sanitation, hygiene and contaminated water
- Generation of extra waste (eg-plastic,plastic..etc)
- Disposal of dead bodies
- Inadequate food supply and storage

Institutional arrangements

- Most of the disaster situation is to be managed at State and District levels.
- The centre plays a supporting role and provides assistance when the consequences of disaster exceed district and State capacities.
- The centre mobilizes support in terms of providing emergency teams, support personnel, specialized equipments and operating facilities depending on the scale of the disaster and the need of the State and District.



Central level

- The following direction decision-making and standing bodies are responsible for disaster management at the central level
- Union cabinet, headed by the prime minister
- Empowered group of ministries, headed by the deputy prime minister
- Crisis Management Committee (NCMC) under the chairmanship of the cabinet secretary
- Technical organizations such as Indian Meteorological Department (cyclone/earthquake), central water commission (floods), building material and technology promotion council (construction laws) , BIS(norms)..etc
- Establish a specialized and earmarked response team for dealing with nuclear / biological / chemical disasters
- Establish search and rescue teams in each state

State level

- The responsibility to cope with natural disasters is essentially that of the state government.
- The role of the central government is supportive.
- It supplements the physical and financial resources of the state governments.
- Most of the states have Relief Commissioners Secretaries who are in charge of the relief and rehabilitation measures in the wake of natural disasters in their states.
- The Chief Secretary is in overall charge of the relief operations in the state

District Level

- The district administration is the focal point for the implementation of all government plans and activities.
 - Considerable powers have been vested in the District Collector to carry out relief operations in the shortest possible time.
 - In the event of shortage of funds, the Collector is also empowered to draw money from the district treasury under his emergency powers.
 - The actual day-to-day functions of administering relief are the responsibility of the Collector/ District Magistrate/Deputy Commissioner who exercises co-ordinating and supervising powers over all departments at the district level.
 - These local bodies can be effective instruments in tracking disasters through early warning system, relief distribution, providing shelter to the victims, medical assurance..etc
-
- ✓ Other than national, state, district and local levels , there are various institutional stakeholders who are involved in disaster management at various level in the country
 - ✓ These include the police and para military forces, civil defence and home guards , fire services, ex-servicemen, non-governmental organization, public and private sector enterprises, media..etc plays an important role

ROLE OF GIS IN DISASTER MANAGEMENT

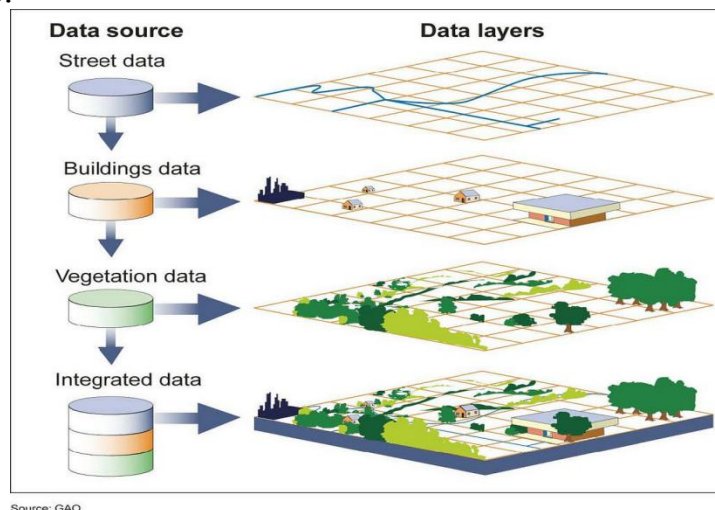
GIS

- ✓ A geographic information system (GIS) is a computer system for capturing, storing, analyzing, and displaying data related to positions on Earth's surface.
- ✓ GIS can show many different kinds of data on one map, such as streets, buildings, and vegetation

- ✓ This enables people to more easily see, analyze, and understand patterns and relationships.

INTRODUCTION

- ✓ India is vulnerable to natural and man-made disasters.
- ✓ All disasters are spatial in nature. GIS techniques act as a decision support tool.
- ✓ Decision making can possible by analysis of different GIS layers.
- ✓ Currently socio-economic and geo-spatial data is useful for management and planning of disasters as well as tackling of disastrous condition.
- ✓ Various departments and agencies who are stakeholders using GIS in the disaster management process.
- ✓ Evolution of computer technology and availability of hardware is helpful for rapid expansion of GIS in both disaster research and practice.
- ✓ GIS is useful for hazard zone mapping and during emergency conditions mitigation of people can easily possible using this maps.
- ✓ GIS much beneficial in mitigation strategies and preparedness plans.
- ✓ Real time geographic data can improve the allocation of resources for response.



GIS in Disaster Management is done by following steps:

1. Planning and Analysis
2. Situational Awareness
3. Data Management
4. Field Operations

Planning and Analysis:

- ✓ GIS is the most complete information system for modeling, analyzing spatial data and displaying community vulnerability.
- ✓ When we identify hazard locations with critical infrastructure, Processed GIS Models can be useful for determination of event impact and necessary mitigation requirement.
- ✓ Preparedness is important when disastrous event occurs.
- ✓ On analysis of risk and hazards is beneficial in Emergency management program

Situational Awareness:

- ✓ Disaster and emergency management in situational awareness is essential thing.
- ✓ GIS techniques plays vital role to provide locational information of the event, that is, where is the event happened and what happening exactly in real time.
- ✓ Also by linking people, processes spatial information situational awareness established.
- ✓ GIS map interface important in handling emergency condition.

Data Management:

- ✓ To achievement of preparedness, gathering of information and its advance data storing is important.
- ✓ In GIS, integration of information from other sources is possible.
- ✓ GIS solution is a standards-based.
- ✓ Accurate cataloging of GIS data provide useful information during emergency conditions

Field Operations:

- ✓ Field data is very important in GIS applications and Mobile GIS provides crucial information.
- ✓ Field teams captures information and sent back to user.
- ✓ So ground information useful for recognizing actual event conditions.
- ✓ Then new data can be sent to operation teams in field (where disaster occur), so they have the information possible for protecting lives and providing safety to people.
- ✓ Whether its response or recovery phase, Mobile GIS provides right information

Mitigation

- ✓ GIS technology provides the capability to map and analyze hazards of all types and visualize their potential impacts.
- ✓ When hazards are fused with critical infrastructure, population densities, and other community values, vulnerabilities can be observed, modeled, and better understood.
- ✓ GIS optimizes the planning analysis process as follows:

a. Identify and map, natural and technological hazards:

- Natural hazards may include
- Earthquake faults
- Flammable vegetation
- Areas prone to severe weather events (Landslides, floods)

b. Identify and map critical values at risk:

- Population densities
- Critical infrastructure including government facilities, hospitals, utilities, and public assemblies
- Natural resource

c. Identify values at risk within the impacted areas of natural and/or technological hazards.

GIS is used to model potential events (plumes, explosions, floods, earthquakes, etc.) and display projected areas of extreme, moderate, and light damage that could be caused by the event.

d. Develop site-specific strategies for mitigation to reduce losses

- Mitigation includes activities that prevent an emergency, reduce the chance of an emergency, or reduce the damaging effects of unavoidable emergencies.
- Mitigation activities take place before and after emergencies.
- Other mitigation functions may include enforcing building and fire codes, designating specific routes

Preparedness

- ✓ Emergency managers develop plans of action for when disaster strikes.

- ✓ Priorities for action plan development are identified in the planning and analysis process.

Common preparedness measures include some of the following:

- ✓ Critical facility emergency contingency plans
- ✓ Communication plans with easily understandable terminology and chain of command
- ✓ Proper maintenance and training of emergency services
- ✓ Developing the facilities, staff, equipment, and tools necessary to plan, monitor, and facilitate emergency management decision making and information sharing

GIS technology is utilized for preparedness as follows:

- Site selection for adequate evacuation shelters with consideration of where and how extensively an emergency might occur
- Selecting and modeling evacuation routes
- Identification and mapping of key tactical and strategic facilities
 - Hospitals
 - Public safety facilities
 - Suppliers to support response (food, water, equipment, building supplies, etc.)
- Training and exercises to test preparedness
- Identify incident locations and impacts; map incident perimeters.
- Collect damage assessment, identify casualties, and prioritize for allocation of public safety resources.
- Develop and distribute incident action plans.
- Providing a key capability for the command and control information system that enables situational awareness and incident management support.

Response

- ✓ Emergency management assists in the mobilization of emergency services and resources to support first responders for complex emergencies.
- ✓ This can include specialist rescue teams, logistical support, public safety, volunteers, non-governmental organizations (NGOs), and others.
- ✓ The Emergency Operations Center (EOC) is responsible to support incident management operation needs and maintain continuity of operations for the community.

- ✓ Acquiring, managing, and maintaining status of resources from various locations

GIS supports the response mission as follows:

- Provide warnings and notifications to the public
- Determine appropriate shelter activation based on the incident location and optimum routing for affected populations to access appropriate shelters
- Establish the capability to collect and share information among department heads for emergency decision making to support emergency operations and sustain government operations
- Maintain incident status and progress; facilitate damage assessment collection and analysis
- Prepare maps, briefs, and status reports

Recovery

- ✓ The aim of the recovery phase is to restore the affected area to its original state.
- ✓ Short-term recovery is focused on restoring essential services and support.
- ✓ Long-term recovery efforts are concerned with actions that involve rebuilding destroyed property, reemployment, and the repair of essential infrastructure.

GIS is recovery by providing a central information repository for assessment of damage and losses that provides:

- Identification of damage
- Locations of business and supplies necessary to support reconstruction
- Assess overall critical infrastructure damage and determine short-term actions for the following:
 - ✧ First aid and health
 - ✧ Additional shelter needs
 - ✧ Optimum locations for public assistance
 - ✧ Alternate locations for government operations if government facilities are damaged
 - ✧ Alternate transportation routes for continued operations
- Monitoring progress by specific location of reconstruction efforts for both long-term and short-term needs

- Publishing maps to share information with the public and other government organizations of progress toward recovery objectives

Conclusion

- ✓ Disaster events are increasing, populations are moving into more disaster-prone landscapes, and new threats exist.
- ✓ To meet the demands, professional tools and technology are required.
- ✓ GIS technology can serve a variety of purposes in supporting the work flows and mission of the emergency management profession.
- ✓ GIS provides a platform for the storage and management of all types of data that can be easily accessed for emergency decision support.

Some of the GIS Software are ArcGIS Pro , ArcGIS Desktop, QGIS ..etc

Benefits of GIS in disaster management

- Accurate data availability
- Location of site accurately within sufficient time
- Real time visualization of area
- Reduce the time

INFORMATION TECHNOLOGY

- ✓ Information and Communication Technologies (ICTs) play a significant role in disaster prevention, mitigation response and recovery.
- ✓ Timely, predictable and effective information is much needed by government agencies and other humanitarian actors involved in rescue operations and decision-making processes.

Introduction

- Disaster management activities in case of a disaster are focused on three primary objects like protecting life, property and environment.
- Disaster is of two types –

- 1) Natural disaster (Earthquakes, flood, Cyclone, Forest fires etc)
- 2) Man- made disaster (nuclear, terrorism, biological)

- Communication of information about a disaster to a population at risk and appropriate actions to mitigate that hazard is an important part of information technology.

- The hazard or disaster sometimes cannot be avoided but the public warning which is primary goal of the information technology and to ensure to the greatest extent so that hazard may not be a disaster.
- The success of information technology such as evacuation of the people from the hazardous site, to reduce damage to the property and thus minimizing human suffering.

Key Players in Disaster Warning

The following components are considered as the key parties that play major roles in disaster management process-

1. Communities
2. Local Government
3. National Governments

Communities-

- The communities residing at the bank of the sea or in the hilly area or in the earthquake zone or other disaster prone areas are to be alerted through radio or television messages of on setting any hazard or disaster.
- Community can also be made aware of potential negative impacts to which they are exposed and specific actions to be taken to minimize the threat of loss or damage.

Local Government-

- Local Government should have considerable knowledge of the hazards to which their community is exposed.
- They must be involved in design and maintenance of early warning systems and able to advice or instruct local population for their safety and reduces the potential loss of resources.

National Governments-

- National Governments are responsible for policies and framework to facilitate the early warnings in addition to the technical system for the preparation and issuance of timely and effective warning to the respective areas of the country.
- They should ensure the warnings and related responses are directed towards to the most vulnerable population
- Through the design of entire disaster response and early warnings framework that helps specific needs of related micro and macro level population.

Moreover NGO, private sectors, media and scientific community have a critical and efficient role for mitigation of any natural hazards by

supporting scientific and systematic monitoring and warning services to the people's at risk.

Components of Information Technology Used in Disaster Management

1. Awareness program
2. Radio & television
3. Telephone/Mobile
4. Short Message Service.(SMS)
5. Auto- ALERT through Siren /Emergency bell

Awareness program:

- To combat disaster, awareness of the risk population about the possible disaster and its combat –strategies is utmost important.
- It can be done in various ways.
- If target population are mostly common illiterate people, audio visual aid like Video conferencing, tale- communication even with the experts who are not available at field level can play a great role in educating people to mitigate disaster like situation.

Radio & television –

- The most traditional electronic media used for disaster warning and a widespread effect to the people.
- The effectiveness of this media in the developing countries and rural environments where the teledensity is relatively low and there it can be used to spread the warning quickly to a broad population.
- A study on this media revealed that the effectiveness of radio and television with a easy understandable language of warning can reduce the potential death toll of catastrophic, cyclonic and tidal bore.
- But only drawback of this system is that at night this media are generally switched off.

Telephone/Mobile-

- The landlines and Mobile phones has an important role in warning the communities at stake for an incoming danger of a disaster.
- A phone call with warning saved many lives in at coastal region.
- However there are two drawbacks to warn the people through telephone are –

i. Installation of telephone in the rural areas in all India still is not satisfactory even if there is an exponential use of mobile phone in recent past has mainly bounded in urban areas – particularly in rural and coastal

areas the communities are mainly fisherman communities still think that mobile phone is a luxury.

ii. The other drawback is congestion of phone lines before and during the disaster resulting incomplete phone calls at vital period.

Short Message Service.(SMS) –

- The SMS is allowable in most of the mobile phone and permits sending of short messages amount the mobile phone an even land line.
- In case of failure of network the SMS can work on a different band and can be sent or received even when phone lines are congested.
- Affected coastal areas were unable to contact relatives and friends through telephone but they could be able to communicate to each other through SMS.
- Other communication technologies are used like Cell broadcasting, satellite radio, internet or e-mail,.. etc to warn the people at stake in case of a impending disaster.

Auto- ALERT through Siren /Emergency bell:

- People in villages who ate not exposed to mobile phones... etc can be brought under the auto alert systems of sirens or emergency bells which starts on its own whenever any alert message is detected.
- They can be installed at offices of local administrations or police stations in the locality.

RISK ASSESSMENT

The identification, evaluation, and estimation of the levels of risks involved in a situation or a hazard

The overall process or method

1. Identify hazards and risk factors that have the potential to cause harm (hazard identification).

2. Analyze and evaluate the risk associated with that hazard (risk analysis, and risk evaluation).

3. Determine appropriate ways to eliminate the hazard, or control the risk when the hazard cannot be eliminated (risk control).

Components of information technology in risk assessment

The risk assessment methodology comprises nine primary steps

Step 1-System Characterization

Step 2-Threat Identification

Step 3-Vulnerability Identification

Step 4-Control Analysis

Step 5-Likelihood Determination

Step 6-Impact Analysis

Step 7-Risk Determination

Step 8-Control Recommendations

Step 9-Results Documentation

STEP 1: SYSTEM CHARACTERIZATION

- The first step to describes the system-related information used to characterize an IT system and its operational environment.
- It also suggests the information-gathering techniques that can be used the information relevant to the IT system processing environment.

System related information

- ✓ Identifying risk for an IT system requires a keen understanding of the system processing
- ✓ The person who conduct the risk assessment must first collect system related information like hardware, software, data and information, system interface (eg. External and internal connectivity)..etc

Information gathering techniques

- Questionnaire
- On-site interview
- Document review
- Use of automated scanning tool

STEP 2: THREAT IDENTIFICATION

- The goal of this step is to identify the potential threat-sources and compile a threat statement listing potential threat-sources that are applicable to the IT system being evaluated.
- A threat source is defined as any circumstance or event with the potential to cause harm to an IT system.

- The common threat sources can be natural, human, or environmental.

STEP 3: VULNERABILITY IDENTIFICATION

- The analysis of the threat to an IT system must include an analysis of the vulnerabilities associated with the system environment.
- The goal of this step is to develop a list of system vulnerabilities (flaws or weaknesses) that could be exploited by the potential threat-sources

System Security Testing

- Some methods, employing system testing, can be used to identify system vulnerabilities efficiently, depending on the criticality of the IT system and available resources
- Test methods include
 - Automated vulnerability scanning tool
 - Security test and evaluation (ST&E)
 - Penetration testing

STEP 4: CONTROL ANALYSIS

- The goal of this step is to analyze the controls that have been implemented, or planned for implementation, by the organization to minimize or eliminate the likelihood (or probability) of a threat's exercising a system vulnerability
- There are two types of control methods
 - 1. Technical control**

It safeguards the computer software, hardware.. etc
 - 2. Non-technical control**

It involves management and operational control like security policies, operational procedures, physical security..etc

Control categories

1. Preventive controls

Attempts to violate security policy and include controls such as access control encryption and authentication

2. Detective controls

It warns violations or attempted violation of security policy and include such as intrusion detection methods..etc

STEP 5: LIKELIHOOD DETERMINATION

To derive an overall likelihood rating the following governing factors must be considered:

- Threat-source
- Nature of the vulnerability
- Existence and effectiveness of current controls

The likelihood rating are high, medium, low

STEP 6: IMPACT ANALYSIS

- The next major step in measuring level of risk is to determine the adverse impact resulting from a successful threat exercise of a vulnerability.
- The mission of impact analysis prioritizes the impact level associated with the compromise of an organization information assets based on a qualitative and quantitative assessment of the sensitivity of those assets

Advantages of qualitative impact analysis

It prioritizes the risk and identifies areas for immediate improvements in addressing the vulnerabilities

Advantages of quantitative impact analysis

It provides a measurement of the impact magnitude, which can be used in the cost benefits analysis of recommended controls

Disadvantages of qualitative impact analysis

It does not provide specific quantifiable measurements of the magnitude of the impacts, therefore making a cost benefit analysis and any recommended controls difficult.

Disadvantages of quantitative impact analysis

Depending on the numerical ranges used to express the measurement, the meaning of the quantitative impact analysis may be unclear, requiring the result to be interpreted in qualitative manner

STEP 7: RISK DETERMINATION

- The purpose of this step is to assess the level of risk to the IT system.
- The adequacy of planned or existing security controls for reducing or eliminating risk.

STEP 8: CONTROL RECOMMENDATIONS

- During this step of the process, controls that could mitigate or eliminate the identified risks, as appropriate to the organization's operations, are provided.
- The controls is to reduce the level of risk to the IT system and its data to an acceptable level.

STEP 9: RESULTS DOCUMENTATION

- Once the risk assessment has been completed (threat-sources and vulnerabilities identified, risks assessed, and recommended controls provided), the results should be documented in an official report
- Risk assessment report that describes the threats and vulnerabilities, measures the risk, and provides recommendations for control implementation
- In this way the information technology plays an important role in disaster management and also in risk assessment process

NATIONAL POLICY ON DISASTER MANAGEMENT

Vision

To build a safe and disaster resilient India by developing a holistic, proactive, multi-disaster oriented and technology driven strategy through a culture of prevention, mitigation, preparedness and response.

DM involves a continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary or expedient for:

- Prevention of danger or threat of any disaster.
- Mitigation or reduction of risk of any disaster or its severity or consequences.
- Capacity building including research and knowledge management.
- Preparedness to deal with any disaster.
- Prompt response to any threatening disaster situation or disaster.
- Assessing the severity or magnitude of effects of any disaster.
- Evacuation, rescue and relief.
- Rehabilitation and reconstruction.

A typical DM continuum comprises six elements; the pre-disaster phase includes prevention, mitigation and preparedness, while the

post-disaster phase includes response, rehabilitation, reconstruction and recovery.

DISASTER MANAGEMENT CONTINUUM



A legal and institutional framework binds all these elements together

Approach

A holistic and integrated approach will be evolved toward disaster management with emphasis on building strategic partnerships at various levels.

The themes underpinning the policy are:

Community based DM, including last mile integration of the policy, plans and execution.

- Capacity development in all spheres.
- Consolidation of past initiatives and best practices.
- Cooperation with agencies at national and international levels.
- Multi-sectoral synergy.

The **objectives of the national policy** on disaster management are:-

- Promoting a culture of prevention, preparedness and resilience at all levels through knowledge, innovation and education.
- Encouraging mitigation measures based on technology, traditional wisdom and environmental sustainability.
- Mainstreaming disaster management into the developmental planning process.
- Establishing institutional and techno-legal frame works to create an enabling regulatory environment and a compliance regime.

- Ensuring efficient mechanism for identification, assessment and monitoring of disaster risks.
- Developing modern forecasting and early warning systems backed by responsive and safe communication with information technology support.
- 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 for ensuring safer living.
- Promoting productive and proactive partnership with media in disaster management

DISASTER DAMAGE ASSESSMENT

Damage Assessment

Damage Assessment is the process for determining the nature and extent of the loss, suffering, and/or harm to the community resulting from a natural, accidental or human-caused disaster.

Damage assessment provides situational awareness and critical information on:

- Type, scope and severity of the event
- Impact on individuals and communities
- Additional resource needs
- Justification for disaster declaration
- Emergency public information
- Future hazard mitigation projects

Gathers estimates on:

- Number of persons displaced and in need of housing
- Number of persons in shelters
- Number of persons injured
- Number of verified fatalities
- Number, degree of structural loss, and financial cost of private property damage

Damage and Needs Assessment

- **Situation (Damage) Assessment** - What has happened (the effects of the disaster its magnitude and effects on society, the infrastructure and the environment)
- **Needs Assessment** - What Needs to be Done (The level and type of assistance required)

Real Time Data

What has happened? (damage assessment)

- Area affected
- Number of people affected
- Mortality & morbidity
- Types of injuries & illnesses
- Characteristics of affected population
- Medical, water, sanitation, nutrition
- Damage to homes & commercial buildings
- Damage to agriculture & food supply system
- Level of local response & capacities
- Level of response by NGOs & other agencies

Reports

1. Flash report
2. Initial report
3. Interim reports
4. Technical reports
5. Final report

Flash report

It should be submitted quickly to confirm the disaster has actually occurred

Initial report

It shows the

- ✓ Severity of disaster
- ✓ Actions being taken locally
- ✓ Local coping capacities (available resources)
- ✓ Immediate priorities for external relief

Interim report

- ✓ With the initial report report additional information is submitted every 24 hours

- ✓ With this report need for relief and need for rehabilitation and reconstruction

Technical report

- ✓ It provides technical report for specialist
- ✓ Example : engineers and officials responsible for emergency care

Final report

It shows the summary of

- ✓ What happened
- ✓ How the response was managed
- ✓ Lessons learnt

Processes in Damage and Needs Assessment (DANA)

1. Form assessment team/s
2. Develop Standard Operating Procedures
3. Team equipment and tools
4. Identify information users and needs
5. Design survey forms
6. Identify data collection methods
7. Standard briefing instructions
8. Collect or source baseline information
9. Training/simulation

1. Form assessment Teams

- Multidisciplinary teams
- Volunteerism is the essence
- Composed of small size, during actual deployment

2. Develop Standard Operating Procedures

- Team activation
- Team roles/individual roles
- Logistics, transport Logistics
- Communication
- Staff safety
- Reporting requirements

3. Team equipment & tools

- Prepare standard survey team equipment list
- Keep the necessary materials ready

- Orientate the team members on the use of equipments; like setting equipments; like setting-up a tent, life jacket, and map reading etc.

Inspection Team Equipment Checklist

- Area maps (preferably laminated)
- Water soluble markers for laminated maps
- Notebooks or pads
- Pencils/pens
- Binoculars
- Camera and spare film
- Fluids (coffee/tea)
- Rations
- Anti-motion sickness tablets
- Sick bags
- Personal equipment (sunglasses, suitable clothing, caps)

4. Identify information needs & users

- Identify needs before hand to save time at the actual time of collection
- Prioritize information
- Information may be useful for media and general public

5. Design survey forms

- Various kinds of reports are needed - technical, official, confidential and those for public release through the media for effective response
- Common format to be developed and used
- Designed by multiple users related to assessment and response
- Design in consultation with specialists in each sector
- Clear
- Easy to complete

Serial Number	Location (district, town or village)	Total number of people requiring food	Response Status (number of people being provided with food under local arrangements)	Unmet needs (number of people for whom external supplies of food are requested. Say if cooking equipment and cooking fuel are required)	Priority
(a)	(b)	(c)	(d)	(e)	(f)
7.1					
7.2					
7.3					
etc					
Total					

6. Data collection methods

- Informal reports
- Visual inspections
- Interviews with key informants
- Special interviews

7. Standard briefing instructions

- Prepare standard briefing instructions to before sending a survey mission.

8. Collect the Baseline information

- Comparison of survey with Baseline information is valuable for response and recovery plans.
- Specialist government agencies keep baseline information.
- NGOs should include contacts of relevant agencies through which baseline information can be obtained.

Baseline Data

- Area maps and plans
- Census and statistics agencies
- National, state and local government Maps
- Statistics
- Plans
- Lists of agency staff
- Government resources
- Community capacities
- Contact numbers for agencies, donors,superiors, embassies, media, specialized technical experts
- Baseline data should be up-dated from time to time, so that it is relevant and reliable when needed

9. Simulations/training

The teams must be given training on following aspects:

- Use of survey forms
- Reporting requirements and process
- Living in the field
- Use of equipment and tools
- Personal safety
- Simulations to enhance learning

- Team wide debriefing on lessons learnt at the end of each mission

Context of Damage Assessment

- Primary focus is on condition of physical assets:
 - Buildings (Residential, Office, Commercial, Lifeline etc.)
 - Roads and Bridges
 - Water supply and sanitation structures
 - Dams and other irrigation structures
 - Industrial facilities (including power plants)
 - Ports and other coastal structures
 - Electrical and Communications system structures

Damage Assessment for Buildings

- ✓ Method should dependent on building type
- ✓ Very large number of buildings are likely to be damaged in a major disaster – Method should be relatively rapid
- ✓ Structural repairs are based on technically detailed evaluation – Method should be technically rigorous
- ✓ Method should consider the variations in international “best practices”

Approximate Equivalence Between Existing Damage Scales for Buildings

Damage Level (%)	HAZUS-99	FEMA-273	EMS-98 / MSK-64	ATC-13	ATC-20	
0	No-Damage Limit State (Grade 0)					
10	Slight Damage	Immediate Occupancy	Grade 1	Slight	Green Tag	
20			Grade 2	Light		
30		Damage Control		Grade 3		Moderate
40	Moderate Damage		Life Safety		Heavy	Yellow Tag
50		Extensive Damage		Limited Safety		
60	Near Collapse		Grade 4	Major		
70					Partial Collapse	Major
80	Extensive Damage	Near Collapse	Grade 4	Major		
90					Partial Collapse	Major
100	Collapse Limit State (Grade 5)					

Proposed Procedure for Damage Assessment for Buildings

International experience clearly shows that a single “fit-all” methodology not feasible to satisfy all short, medium and long-term objectives

Three-step methodology has been proposed:

- Rapid Safety Assessment
- Detailed Safety Assessment
- Engineering Evaluation

Proposed Procedure for Damage Assessment for Buildings

Rapid Safety Assessment

- ✓ Required for ALL damaged buildings after a disaster
- ✓ Method is based on ATC-20 with suitable modifications

Detailed Safety Assessment

- ✓ Required for all doubtful buildings
- ✓ Required for all buildings being considered for compensation
- ✓ Method is based on international best practices after elimination of deficiencies in existing practice

Engineering Evaluation

- ✓ Required for buildings considered for engineered rehabilitation /retrofitting

UNIT-5

DISASTER MANAGEMENT : APPLICATIONS AND CASE STUDIES AND FIELD WORKS

LANDSLIDE HAZARD

Landslide hazard is commonly shown on maps, which display the spatial distribution of hazard classes

LANDSLIDE HAZARD ZONATION (LHZ)

Landslide hazard zonation refers to “the division of the land in homogeneous areas or domains and their ranking according to degrees of actual / potential hazard caused by mass movement”

The factors causing landslide are

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

Natural Hazard (H) : The probability of occurrence of a potentially damaging phenomenon with specified period of time and within a given area

Vulnerability (V): The degree of loss to a given element or set of element at risk resulting from the occurrence of a natural phenomenon of a given magnitude. It is expressed on a scale from 0 (no damage) to 1 (total loss).

Specific Risk (Rs): the expected degree of loss due to a particular natural phenomenon. It may be expressed by the product of H and V.

Element at Risk (E): the population, properties, economic activities, including public service, etc., at risk in a given area.

Total Risk (Rt): the expected number of lives lost, persons injured, damage to property, or disruption of economic activity due to a particular natural phenomenon. It is therefore the product of specific risk (Rs) and elements at risk (E) gives the total risk as given in equation

$$R_t = (E) * (R_s) = (E) * (H * V)$$

USES OF LANDSLIDE HAZARD ZONATION

The LHZ maps have multi uses, some of which are listed below.

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

ASSUMPTION FOR LHZ

1. It is considered that future slope failures are most likely to occur in geologic, geomorphologic and hydrologic situations that have led to past failures.
2. In a given study area the factors that cause landslides can be rated or weighted.

3. If conditions that promote instability can be identified, it is often possible to estimate their relative contribution and assign them some spatial quantitative index

MAPPING SCALE FOR LANDSLIDE HAZARD ANALYSIS

- The amount and type of data has to be stored in a GIS for landslide management depends very much on the level of application, or the scale of the project management.
- Natural hazards information should be included routinely in development planning and investment project preparation.
- Development and investment projects should include a cost / benefit analysis of investing in hazard mitigation measures, and weigh them against the losses that are likely to occur if these measures are not taken
- Selecting the working scale for a slope instability analysis is determined by the purpose for which it is executed.
- The following scales of analysis, which were presented in the International Association of Engineering Geologist's (IAEG 1976) monograph on engineering geology, can also be distinguished in landslide hazard zonation
 - National Scale (<1:1000,000)
 - Regional and Synoptic Scale (1:100,000 – 1:1000,000)
 - Medium Scale (1:25,000 – 1:50,000)
 - Large Scale (1:5,000 – 1:15,000)
 - Site investigation Scale (>1:2,000)

The national hazard zonation mapping scale is intended to give a general inventory of problem areas for an entire country that can be used to inform national policy makers and the general public

The regional mapping scale is mean for planners in the early phases of regional development projects or for engineers evaluating possible constraints due to instability in the development of large engineering projects and regional development plans.

Medium scale hazard maps can be used for the determination of hazard zones in areas affected by large engineering structures, roads and urbanization.

At **large scale** level, the hazard maps are produced mainly for authority dealing with detailed planning of infrastructural, housing, or industrial projects, or with evaluation of risk.

At site investigation scale, the hazard maps are made to plan and design of engineering structures (buildings, bridges, roads etc), and in detailed engineering measures to mitigate natural hazards (retaining walls, check dams etc.)

METHODS FOR LANDSLIDE HAZARD ZONATION

- In recent past, various methods and techniques have been proposed to analyze the causative factors of landslides and produce maps portraying the probability of occurrences of similar phenomenon in future.
- A brief outline of different methods described below

Landslide hazard zonation methods



Direct method

Indirect method



Geomorphological analysis

1.Heuristic approach
2.Statistical approach

Direct method

- This method consists of geomorphological mapping where the earth scientist evaluates the direct relationship between the hazard and the environmental setting during the survey at the site if the hazard event.

- The basis for this approach was outlined by Kienholz, who developed a method to produce a combined hazard map based on the mapping.
- The process is based on the past and present landslides are identified and expert opinion of those sites where failures are most likely to occur and has reasoning of analogy
- The decision rules are difficult to formulate as they vary from place to place
- It does not require the digitizing of many different maps
- The detailed fieldwork requires the considerable amount of time as well
- The accuracy of a resulting hazard map will depend completely on the skill and experience
- **Geomorphological maps** of the same area made by different geomorphologists may vary considerably
- A number of methodologies for landslide susceptibility zonation have been proposed which can be grouped into 6 categories
- The distribution analysis only depicts direct mapping of landslide locations from field surveys or aerial photographs
- In this type of analysis, GIS is used to digitize landslides prepared from the field of survey maps, aerial photographs and remote sensing images
- In qualitative analysis, subjective decision rules are applied to define weights and its ratings based on the experience of experts

INDIRECT METHOD

- The indirect method includes two different approaches namely the **heuristic** (knowledge driven) and **statistics** (data driven) **techniques**
- In **heuristic approach**, the earth scientists use the expert knowledge of an individual to assign weightage values to the series of parameter maps
- The terrain conditions of a large number of locations are summed according to these weights, which can be grouped into hazard classes

- This normally based on the knowledge available to the experts on the causes of landslides in the particular area of investigation
- Stevenson developed an empirical hazard rating system for an area in Tasmania
- On the basis of his expert knowledge on the caused factors of slope instability, he assigned weighting values to different classes in a number of parameter maps
- In statistical landslide hazard analysis, the combination of factors that have led to landslide occurrences in the past, are determined statistically and qualitative predictions are made for landslide free areas with similar conditions

Basis of spatial landslide hazard mapping

The ultimate goal of landslide hazard mapping studies is to protect the population, the economy and the environment against potential damage caused by landslides

- ➔ Develop, update periodically and widely disseminate risk maps and information related to decision-makers, general public and communities at risk in an appropriate format
- ➔ Develop system of indicators of disasters risk and vulnerability at national and sub-national scales
- ➔ This system will enable decision-makers to assess the impact of disasters to assess the impact of disasters on social, economic and environmental conditions and to disseminate the results for the decision makers, public and population at risk
- ➔ Record, analyze, summarize and disseminate statistical information on disaster occurrences, impacts and losses on a regular basis through international, national, regional and local mechanisms

LANDSLIDE HAZARD ZONATION ZONATION: CASE STUDIES

- ▲ Landslide is routine geological process on earth's crust, but recorded under disasters due to loss of lives and property.
- ▲ Prevention and mitigation of disaster can be planned if detected prior to the occurrence
- ▲ The area surrounded by pre occurred landslide at Bhilar in Maharashtra is chosen for the study.
- ▲ The effort has been made to study the Geo-informatics approach containing Remote sensing data and GIS as software integrated tool towards Landslide Hazard zonation.
- ▲ The various Spectral signatures and the image interpretation keys with respect to slope instability and various image data to identify Pre-occurred events and vulnerable sites are studied and used.
- ▲ The methodology considers factors in the form of various thematic layers like lithology, slope, morphology, slope aspect, soil, relief, drainage, land use and pre-occurred landslides in the area generated using remote sensing data and GIS tools.
- ▲ From landslide hazard zonation map the hazardous locations are extracted from the study area and checked by the post analysis during field visit.
- ▲ The vulnerability zonation mapping and analysis of settlement and infrastructural facilities in high risk zone has been carried out.
- ▲ The study demonstrates high degree of hazardousness at Bhilar and Godvali.

Introduction

- The landslides are hazards usually triggered by the neo-tectonic movements, earthquakes, heavy precipitation and those induced due to land-use changes such as felling of trees, agriculture, mining and road cutting in hilly terrain.
- Landslide is a general term used to describe the down-slope of soil, rock and organic material under the influence of gravity.
- The remote sensing and GIS based approach to map and study methodology involves generation of geomorphic map, NDVI map, soil map, slope map, DEM, drainage and lineament map, land use / land cover change map.
- LANDSAT TM and ASTER images have been used to generate a few of these thematic maps.
- To identify the vulnerable areas, the above-mentioned parameters were analyzed in a GIS by assigning appropriate ranks and weights.
- The result is a landslide hazard zonation map showing regions with varying degrees of vulnerability to landslides
- This will enable to propose and implement suitable mitigating measures, thus preventing loss of life and property in the hilly area.
- Landslides affect at least 15 per cent of the land area of India—an area which exceeds 0.49 million km² (ndma.gov.in).
- The landslide situation in the country is further compounded by increased vulnerabilities related to rapidly growing population, unplanned urbanization and fast-paced industrialization, rapid development in high risk areas, environmental degradation and climate change
- This study aims at proposing the strategy for Landslide hazard zonation mapping to formulate an efficient methodology to delineate the Landslide hazard areas

Study Area

- ✓ In Western Ghats (declared as World Heritage by UNESCO) many human habitats, tourist places & highways are vulnerable to landslide
- ✓ Hence the chosen —hilly areas near Panchgani as study area which connects two major tourist regions of Maharashtra.
- ✓ This Area is blocked many times in rainy season because of landslide & hence due attention must be given to Hazard Zonation Mapping & mitigate recommendations.
- ✓ Landslide hazard zonation helps in identifying strategic points and geographically critical areas prone to landslides along this highway.
- ✓ In this study, a methodology has been developed to identify landslide prone areas using Remote Sensing and tools of GIS environment like ILWIS software

Methodology

Landslide hazard Zonation

- Most popularly, -Natural hazardl is defined as possibility of hazardous occurrences within a given area and in a given period of time.
- It incorporates three components: magnitude, geographical location and time.
- Mapping of these zones demands understanding of influencing processes in the study area and factors causing landslides

Data Source

- ▲ The analysis is based on maps from Survey of India and Geological Survey of India and satellite imageries.
- ▲ A landslide occurrence database was generated from GPS measurements were taken during field survey.

- ▲ Various thematic maps pertaining to slope, aspect, drainage, flow accumulation, lithology, and land cover are generated with the help of ILWIS software for Bhilar and Godvali area.
- ▲ The slope and slope aspect layers were derived from ASTER DEM in ILWIS, while flow accumulation is analyzed from drainage in ILWIS.
- ▲ The NDVI analysis was undertaken to enhance the spectral variation in LANDSAT ETM+ (2005) satellite imageries in order to derive meaningful land use/land cover classification (Journal and Geomatics, 2011).

Input parameter and data preparing

The thematic layers were used for the landslide hazard analysis are listed below:

- Slope
- Drainage
- Lithology
- Land use
- Slope Aspect
- Roads
- Pre-occurred Landslides
- Settlement

The outcome of image processing is a set of thematic maps that are utilized as data inputs in different layers. The data is integrated using GIS technique to analyze the layers

Information Value Method

- Method adopted for the study area is a statistical method, namely the Information Value Method (Yin and Yan, 1988).
- The information value is calculated using the following formula

$$\text{Prior Probability} = \text{nslide} / \text{nmap}$$

$$\text{Information Value} = \log [(\text{nslide} / \text{nmap}) / \text{Prior Probability}]$$

Where:

nmap= Total number of pixels in the map

nslide = Total number of landslide pixels

nmap = Number of pixels in each class

nslide = Number of pixels containing slide

- Negative values indicate negative correlation with landslides Values around 0 indicate uncertainty or no evidence Positive values indicates strong correlation with landslide.

The equation for the final map is:

Landslide Hazard Map = Slide Slope + Slide Flow Accu + Slide Litho + Slide L Cover + Slide Asp + Slide Rd + Slide Settle Where:

Slide Slope = Landslide and Slope Cross Weighted Map

Slide Flow Accu = Landslide and Flow Accumulation Cross Weighted Map

Slide Litho = Landslide and Lithology Cross Weighted Map

Slide L Cover = Landslide and Land Cover Cross Weighted Map Slide Asp = Landslide and Aspect Cross Weighted Map

Slide Rd = Landslide and Road Density Cross Weighted Map Slide Settle = Landslide and Settlement Cross Weighted Map

Parameters with weights for statistical analysis

Parameter Maps	Weights
Slope	7

Drainage/ Accumulation	Flow	6
Lithology		5
Land cover		4
Aspect		3
Roads		2
Settlement		1

ANALYSIS FOR LANDSLIDE HAZARD ZONATION:-

Digital Elevation Model (DEM):

- ➔ The DEM tile was imported in ILWIS environment and proper georeferenced was assigned to it along with WGS 84 coordinate system.
- ➔ Then the sub map was extracted to cover the study area
- ➔ To enhance the accuracy the digitized contour map was prepared from slicing the DEM by 20 M. the sliced DEM was vectored into polygon and then into segment map.
- ➔ This segment map was assigned the respective contour value in value domain.
- ➔ Again the same contour map was interpolated with 0.01 M precision to develop the new final DEM

Digitized contour map:

- ❖ Digitized contour map of 20 M interval was prepared after slicing the DEM.
- ❖ It shows that, the contours are ranging between 800m to 1380m R.L. in the study area.
- ❖ It is observed that in certain elevation range the contours are much closed and nearly basic volcanic rock is present in the form of lava sheets.

- ❖ This area is being eroded since 53 million years

Elevation sliced map:

- ❖ This is the layer prepared after slicing the DEM. It shows slicing of the study area into thirteen different zones of elevation range with 20 M precision.
- ❖ The layer was used to extract the contour data

Slope map in degree:

- ❖ This is important layer in landslide hazard zonation mapping as slope is first causative factor of landslide.
- ❖ From slope stability point of view, the slope map was classified in three groups as Blue color indicates the slope from 0° to 13° as gentle slopes;
- ❖ Yellow color indicates the slope from 13° to 50° as slide prone slopes and red color indicates the slope from 50° to 90° as steep stable slopes

Slope aspect map:

- ❖ The slope aspect map was prepared from DEM. This map shows the ground slope direction with respect to North.
- ❖ It has been observed that in this particular area the slope aspect has a little control over landslide.
- ❖ After studying pre occurred landslides, the slope aspect map was also considered in Information Value Method.
- ❖ Slope aspect map has been sliced into 8 directions

Flow direction map:

- ❖ This map indicates the flow direction of the study area.
- ❖ Each pixel is assigned with direction out of eight in which the precipitated water may flow.

- ❖ It is used to prepare the flow accumulation map by calculating the number of pixels, from the upstream direction flowing towards each pixel

Flow accumulation map:

- ❖ It indicates the number of pixels flowing towards any particular pixel.
- ❖ With the prior information of resolution and rainfall data, it is easy to calculate the volume of water that may accumulate at selected pixel, for known rainfall.
- ❖ Since water plays very important role in landslides the flow accumulation

Village map

- ❖ The village map has been added over each layer combination for getting the relative position of spatial features with respect to village settlement.

Road Map:

- ❖ Contoured topographic map and the satellite data are collectively used to prepare the road map.
- ❖ Road map is simply a vector segment layer digitized on map and satellite imagery.

Land cover map

Since it is having relatively low spatial resolution and also the lower thematic resolution it was given a less weightage in information value method.

Lithology Map:

- ❖ In the study area basaltic rocks are very common. Because of highly oxidizing and humid conditions prevailed in the past, the basalts were weathered to form thick layers of lithomarge clays later on converted to the capping of laterite.

- ❖ Therefore basalts capped by laterite is a common lithology of the area

Discussion

- For the very first time in Maharashtra the information value method has been adopted and implemented by overlaying all the thematic layers to obtain Landslide hazard zonation map.
- This map is divided in five risk zones as Very Low, Low, Moderate, High, and Very High
- In further part of the research from obtained hazard zonation map the only susceptible zone have been delineated to focus on most hazardous zone
- According to vulnerability assessed results over 34 percent area is liable to high- severe landslide risk and within this about 5 per cent has very high to severe risk while about 29 per cent of the total area has high risk of landslide occurrence.
- Such areas include Bhilar and Godvali on eastern slopes of the hill. About 59 per cent area of the study area has low to moderate risk of landslides.
- The analysis shows that unmapped hilly terrain of Mahabaleshwar Tehsil may also lie under hazardous zone of landslide of varying magnitude.

FOREST FIRE CASE STUDIES

- ▲ Forests are major natural resources and they play an important role in maintaining environmental balance.
- ▲ But in this world, every year about 5 billion hectares of forests are damaged due to forest fires.
- ▲ Forest fires are considered as a potential hazard with biological, ecological and environmental consequences

- ▲ The forest fire in Tamil Nadu's Theni hills that claimed the lives of more than 20 trekkers and severely injured many others is a heart-rending tragedy.
- ▲ The forest fire area which is assessed is compared and verified with the real time issue on March 11, 2018.
- ▲ Using forest fire simulation results, the extent of fire damage, rate of spread and direction of spread can be predicted which helps to protect and preserve the forest
- ▲ The forest fire is a major cause of degradation of Indian forests and also it causes wide range of adverse ecological, economic and social impacts.
- ▲ Since the numbers of forest fire incidents are increasing every year, continuous monitoring is of great importance, not only to understand present trends but also to devise a model to predict the possibility of fires in future.
- ▲ Forest fire risk zones are locations where a fire is likely to start, and from where it can easily spread to other areas.
- ▲ About 90% of the forest fires in India are started by humans and meteorological parameters.
- ▲ The recent technologies like remote sensing and GIS helps us by giving a quicker and cost effective analysis for various applications with accuracy for planning.
- ▲ The development in satellite data acquisition techniques and information technologies provide new opportunities for forest fire mitigations and follow up monitoring and rehabilitation efforts economically.

Study area

- ✓ Kurangani is a hill station at the top of the Western Ghats accessed from Bodinayakanur in the Indian state of Tamil Nadu.

- ✓ The hills are characterized by frequently changing weather, low-hanging clouds, chilly atmosphere and strong winds, and are home to a wide range of flora and fauna including Indian gaurs, barking deer, langur's, wild cats, and possibly leopards and tigers.
- ✓ Kurangani has more than 6 small streams.
- ✓ All those streams join together into the Kottakudi river, where they flow into the Vaigai Dam
- ✓ The Kurangani Hills near Bodinayakanur in Theni district are suitable for trekking and nature walks, including a distance of about 12 km walk from Kurangani village to the top Station through the central village.
- ✓ It takes around four to five hours to complete the trek from Kurangani village, the foot hills of the Hills, to reach the top station, while a two-and-a-half hour is enough for the return trip.

Methodology

- It explains the methods to be followed for obtaining the fire behaviours by considering various parameters.

Data Description

SOI Toposheet

- ❖ The land use map (Road and settlement) is prepared from SOI Toposheet.
- ❖ The toposheet given by the survey of India (SOI) contains the details about the natural features.
- ❖ So the reserved forest area details are also clearly available in the Toposheet

SRTM-DEM Data

- ❖ The SRTM data is with a resolution of about 30m.

- ❖ The DEM data contains the details about the study area's topographical features.
- ❖ The topography is nothing, but the Elevation, Slope and Aspect and the study area details

LANDSAT Data

- ❖ Landsat 8 consists of Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) images which contain nine spectral bands with a spatial resolution of about 30 meters for Bands 1 to 7 and 9.
- ❖ The resolution for Band 8 (panchromatic) is 15 meters.

Thematic Layer

Preparation Elevation Map

- ❖ The elevation map is prepared from SRTM-DEM data. resolution
- ❖ From the SRTM-DEM data, the boundary of the study area is added to the Arc map.
- ❖ The elevation details of the study area can be derived by using the extracted mask tool into the Arc tool box.

Slope Map

- ❖ The slope map is prepared from elevation map by using Arc tools in Arc map software.
- ❖ The Arc map will have the spatial analyst tool bar.
- ❖ Using the slope tool from the spatial analyst tool bar, slope map can be derived from the elevation map.

Aspect Map

- ❖ The aspect map can also be derived from the elevation data.

- ❖ The aspect tool from the spatial analyst tool bar is used to derive the aspect map from elevation map

Road Map

- ❖ The Road map contains the details about the type of road and which roads are available in Kurangani forest area for finding the details about the fire.
- ❖ As the road side human activities is more, the road map is prepared by using visual interpretation and then digitized , for which the data is obtained from the **Elevation Layer**
- ❖ The Elevation layer is also one of the important factors for the assessment of forest fire risk zone.
- ❖ The higher elevation indicates the low fire risk due to less temperature and high rainfall.
- ❖ The Elevation varies from 219m to 2436m IRS laboratory.

Settlement Map

- ❖ The Settlement map contains the details about the built up area and commercial areas.
- ❖ The settlement map will be helpful for the identification of the places from the base map.

NDVI Layer

- ❖ The Normalized Difference vegetation Index provides estimate about the vegetation health and means of monitoring the changes in vegetation cover time, and it remains the most well-known and used index to detect live green plant canopies from the multispectral remote sensing data and its values lies between -1 to +1.

Overlay Analysis

- ❖ The above all layers are generated uniformly by using same projection and output cell size.

- ❖ Using weighted overlay tool the Reclassifies values in the input raster are entered into a common evaluation scale of risk, or some similarly unifying scale Multiplies the cell values of each input raster by the raster weight of importance Adds the resulting cell values together to produce the output raster.
- ❖ Finally, a Forest Fire Risk Zone (FFRZ) map was produced based on these analyses using ArcGIS software.

Conclusion

- The various parameters that contribute to the forest fire like elevation, slope, aspect, distance from roads and settlements, NDVI and NDWI map has been prepared.
- The maps are overlaid to obtain the fire risk zone map.
- The areas shown under very high, high and moderate ‘fire risk’ zones are those areas where fire can be unintentionally caused by human activities, and where fire could thus certainly be averted by taking precautionary measures.
- Forest Department, as this type of fire risk zone map would enable the department to set up an appropriate fire-fighting infrastructure for the areas more prone to fire damage.
- Such a map would help in planning the main roads, subsidiary roads, inspection paths, etc. and may lead to a reliable communication and transport system to efficiently fight small and large forest fires.
- This proposed fire risk zone map helped in identifying the area which was burned in the fire accident at the Kurangani forest area on March 11, 2018. From this fire risk zone map, it was estimated that the area burned during the fire accident falls under high fire risk zone.

DROUGHT ASSESSMENT CASE STUDIES

Introduction

- Extreme climate events such as droughts are very common in Malawi and yet their impacts are generally not well factored into the long term National Development Plan .
- Good examples of the potential hazards of the extreme Climate events have been demonstrated by the impacts of the 1948/49 and 1991/92 droughts.
- The two eminent droughts had harsh negative impacts on agriculture, Livestock, wildlife, tourism, water resources and hydroelectric generation.
- The low water levels in the dams led to intense power rationing which resulted to large losses in the economy.
- The impacts of these El Nino related droughts were therefore very severe and could not be accommodated within the limited national resources.
- The government had to seek support from international communities to address their impacts.
- It should be noted that the impact of extreme climate events affects the welfare of the majority of the rural communities and tend to enhance poverty, especially in Malawi where rain-fed agriculture and hydroelectric power forms a major source of food and energy respectively.

- Records from the National Profile of Disasters indicate that the 1991/92 drought impinged heavily on the whole country and 6.1 million people were affected.
- Conversely, the 1948/49 drought was country-wide as well and unspecified number of people died.
- Some of the response actions included intensification of supplementary feeding programmes to vulnerable groups and provision of drugs for waterborne diseases.
- The severe impacts associated with extreme events can be reduced among others, through good understanding of the climate patterns.

Country's Geographical profile

- ✓ Malawi occupies the southern part of the East African Rift Valley and lies between latitude 9 and 17 degrees South and longitude 32-36 degrees East.
- ✓ It is bordered by Mozambique to the south and east, Zambia to the west and Tanzania to the east and north-east. With a total territorial area of 119,140 sq km, the country varies in altitude from near sea level to well over 2,000 meters above mean sea level.
- ✓ Of this area, one fifth is water bodies largely dominated by Lake Malawi which is Africa's third largest lake.
- ✓ The economy of Malawi is heavily dependent on the agriculture sector, with nearly 90 percent of the rural population deriving their livelihood from agriculture(UNDP,1993).

- ✓ In addition, agriculture contributes about 33 percent of the country's export earnings (Primarily from tobacco, tea and sugar), and about 75 percent of the country's employment.

Methodology

Data

- Ten-day , monthly and seasonal rainfall totals for the period 1948/49-2002/2003(55 years), for locations in Malawi have been used in this study.
- Seasonal totals are for the period of November of one year to April of the following year which generally covers the growing period for most crops in most areas in Malawi.
- Hence data for the 1948/49 season covers the period November 1948 to April 1949 and likewise for 2002/2003 covers the period November 2002 to April 2003.

Methods

- ➔ Percentile drought indices have been used for spatial analysis of rainfall data while Standard Precipitation Indices have been used for temporal analysis.

Percentile Index

- ➔ The percentile drought indices have been used in this study.
- ➔ The percentile, which is based on cumulative frequencies, is given as:

$P = ((n-0.5)/m) * 100$ where

P is the percentile value,

n is the rank and

m is the number of years.

- The lower the percentile value the more severe the rainfall deficiency or drought.

Standardized Precipitation Index (SPI)

- There several indices that measure how much precipitation for a given period of time has deviated from historically established norms.
- The Standardized Precipitation Index is used.
- The index measure how the precipitation has deviated from normal as measured by standard deviation.
- The index is produced by dividing the result of subtracting the mean value from the actual value by a standard deviation.
- The index is negative for drought and positive for non-drought condition, with zero as mean.
- For example, SPI of 2 indicates 2 standard deviations above normal while SPI of -2 indicates 2 standard deviations below normal . A drought event is when index is less than or equal to -1.0.

Tools

- Using Microsoft Excel computer software graphs showing time series of departure from normal seasonal rainfall for selected stations were created.
- Using the same software, graphs depicting actual versus normal ten-day rainfall for chosen drought years for selected stations were produced.

- For mapping, Surfer for Windows Software, was used. Microsoft Word was used for writing the report.

Spatial Rainfall Analysis

From the percentile analysis on the rainfall situation during the 55 seasons under study, the following observations were made:

- ▲ During the 55 years there have been two occurrences of severe droughts; 1948/49 and 1991/92 rainfall seasons.
- ▲ There have been four occurrences of serious drought. These were 1967/68, 1972/73, 1982/83 and 1994/95.
- ▲ Localised mild droughts have been more frequent in some areas than others.
- ▲ The 1948/49 drought covered more areas and hence affected a bigger part of the population.
- ▲ The 1991/92 drought covered fewer areas but was more severe in the sense that it lasted longer and hence affected water supplies as well.
- ▲ Analysis shows that both 1948/49 and 1991/92 droughts intensified during the peak rainfall months of January and February and droughts progressed from south to north.
- ▲ Of the drought seasons, 1948/49 was not affected by El Nino, while 1953/54, 1972/73, 1982/83, 1994/95 were affected by El Nino phenomenon.

The droughts that occurred in these areas affected major sectors of the economy such as agriculture, health, education and water sector.

Agriculture

- ❖ It was reported that agriculture production was adversely affected during drought years.
- ❖ Maize yield was particularly affected when dry spell conditions set in during peak rainfall months of January and February and some eases when onset of rains were erratic.
- ❖ In the case of livestock, it was reported that some animals lost weight and died due to lack of food and water, while others were attacked by various diseases such as African swine fever and black coat.
- ❖ As coping mechanisms for both the drought and the ensuing famine, officials from the Food Security advised people to grow sweet potatoes, cassava and early maturing maize varieties.
- ❖ The survey indicated that people actually switched to cassava, sweet potatoes, millet and early maturing maize varieties.
- ❖ In some cases, farmers sold their cattle and other animals and engaged in income generating activities so as to satisfy their needs.
- ❖ Some farmers had to take their animals to localities where there was adequate animal feed and water.
- ❖ Drought relief assistance was provided by CADCOM and GTZ.
- ❖ The relief assistance was in form of maize, maize flour, beans, seeds (beans,soya and ground nuts seeds) and fertilizer, especially during 2001/2002 drought season.

Health

- ❖ The drought were associated with disease outbreaks such as cholera, malaria, diarrhea, kwashiorkor and marasmus.

- ❖ It was also reported that a few people both young and old died due to hunger-related diseases and cholera.
- ❖ The actual figures were difficult to establish.
- ❖ As a response to health problems some NGOs as Save the Children Fund assisted the affected people particularly the children with nutritional food such as locally made Likuniphala and salt.
- ❖ UNICEF also provided similar assistance.

Education

- ❖ The droughts also led to school drop-outs and increased absenteeism among pupils; they had no food to carry to school and were busy looking for food.
- ❖ It was unclear whether teachers were also affected by the droughts.
- ❖ In response to the effects of drought on the education sector, some NGOs have established school feeding programmes in some primary schools.

Water

- ❖ In the water sector, droughts led to the shortage of water.
- ❖ Low levels of water in the rivers and wells were observed and in some cases rivers dried up.
- ❖ This resulted in reduction of water for both human and animal consumption .
- ❖ As way of coping with the drought situation, some farmers had to take their animals to locations where there was adequate feed and water.

Mitigation Measures

- ✧ There was a mixed reaction in terms of whether people were warned in advance about any impending drought.
- ✧ Some people got information on the impending droughts through the radio and the message was passed on to others through informal interactions.
- ✧ On the other hand, some people never got the information at all.
- ✧ As a long term solution to the problems that occur due to droughts, most people suggested that the government should promote irrigations systems in the country particularly in the drought prone areas.
- ✧ In addition, people interviewed also indicated that there is need for the government to make available information on impending drought on time for them to prepare for the drought.

Earthquake vulnerability assessment and buildings and infrastructure

- ✓ Earthquake is one of the deadly natural disasters we have regularly experienced. Nepal and its adjacent areas are vulnerable to very high magnitude of earthquake.
- ✓ The Himalayan belt, Bihar-Nepal border, Assam and North Bengal especially Darjeeling, Jalpaiguri, Alipurduar and Cooch Behar districts fall in this seismic zone.
- ✓ On the basis of investigation, it has been found that recent earthquakes had destructed many human lives and their properties in Nepal and north India.

- ✓ The earthquake was considered to be the main cause for avalanches, landslides, slumps, many cracks and fissures in the adjacent area of Nepal.
- ✓ The present study endeavours to examine the nature, extent, causes and consequences of the tremor of quakes and suggests suitable recommendations for its revival.
- ✓ The specified objectives have been fulfilled by the utilization of maps of Indian Meteorological Department (IMD) and Google images.
- ✓ Necessary maps, diagrams and tables have been prepared for exposition of these problems.
- ✓ A deadly earthquake shook Nepal and sent tremors through Indian subcontinent.
- ✓ On 25th April and 12th May 2015, Nepal and its surrounding area were hit by earthquakes which are considered to be the most devastating in the living memory of the inhabitants of these affected areas.
- ✓ The 7.9 magnitude quake was the strongest to hit Nepal for 81 years.
 - It was the most horrible natural disaster to hit Nepal since the 1934 Nepal-Bihar border earthquake.
 - The quake measuring 7.9 on the Richter scale, which was followed by 97 aftershocks of magnitudes 3.0 to 6.9 on Richter scale, caused heavy casualties in Kathmandu and injured thousand others.
 - The earthquakes had its epicentre at Lumjung, around 80km north-west of Kathmandu.
 - It had its impact in several areas in Nepal and India.
 - It was also felt in northern and north-eastern part of India, China, Tibet, Bangladesh and as far as Pakistan.

- Continued aftershocks occurred throughout Nepal and its adjacent area at 15-20 minutes' intervals, with one shock reaching a magnitude of 6.9 on 26 April at 12:42 IST.
- ✓ A second major earthquake occurred on 12 May 2015 at 12:35 IST with a magnitude of 7.3 on Richter scale.
- ✓ The problem under study is to assess the nature of earthquakes and to determine specifically the extent of this type of disaster, in details through data generated from Indian Meteorological Department (IMD) and Geological Survey of India.
- ✓ The other main problem is to construct unscientific and non-seismically engineered multi storied buildings which had easily collapsed by the tremor, disrupting civic life in Nepal.
- ✓ Nepal and some districts of north India along the India-Nepal border have been selected for this study.
- ✓ Study area is bounded by 21degree33'07.04''N to 30 degree 21'02.53''N Latitudes and 77degree 06'33.77'' E to 95 degree 56'31.16'' E Longitude in Nepal and the states of India, namely West Bengal, Bihar, Uttar Pradesh, Assam and Sikkim.
- ✓ This is represented a zone of transition between the Kunlun range of China and the peninsular plateau of India.
- ✓ It is covering an area of 6,56,558 sq.km. Earthquake of Nepal and India along the Himalayan belt were caused mainly due to collision of Indian plate and Eurasian plate.
- ✓ Indian plate is moving towards north-northeast ward direction at an average rate of about 4.5-5 cm per annum, which causes a stress.
- ✓ The earthquake was caused at the depth of 10 kilometres.

Consequences of Earthquakes:

- ✓ Hazardous effect of Nepal earthquakes depends not only on their magnitude of Richter scale or intensity alone, but also on so many factors, such as geology of the earth crust (lithology, elasticity, soil condition, permissible stress, rock structure, etc.), design of buildings, quality of construction, population pressure, etc.
- ✓ Several villages, towns, human constructions and their properties, lives were completely damaged.
- ✓ Several buildings collapsed like a pack of cards as if they were mud huts.
- ✓ Several buildings, most of them old, collapsed in the densely populated Kathmandu valley.
- ✓ Earthquakes are often followed by landslides and rock avalanches and glacier avalanches in Himalayan hilly areas.
- ✓ At least 18 people at the start of the main climbing season.
- ✓ At least 1000 climbers had been at the base camp of the Everest when the earthquake struck.
- ✓ Because of the poor plane network coverage, the government of India and Nepal were struggling to access the damage on the Everest.
- ✓ At Langtang valley in Rasuwa district, a major tourist destination in Nepal, also famous for trekking, it is said that over 100 people were killed and 120 people were injured or missing.
- ✓ Over 329 people were reported missing after an avalanche.
- ✓ Continuous aftershocks caused a landslide on the Koshi Highway which blocked the section of the road between Bhedetar and Mulghat.
- ✓ As a result of landslide the transport system mainly highways was completely damaged or blocked, which may stop various activities needed for earthquake relief and rescue.

- ✓ The key reason for the very high Nepalese casualties was the construction of non-seismically engineered buildings.

Preventive measures:

- ✓ During earthquake, you run towards safe place like an open area away from buildings, electricity wires, flammable inputs, etc.
- ✓ If you are in the moving car during earthquake, you should stop the car as quickly as possible.
- ✓ If you are staying indoors, you should take shelter under a heavy and hard furniture namely desk, table, bench, etc.
- ✓ You should not run through or near the buildings; always stay in open place until the tremor stop.
- ✓ You should construct seismically engineered (earthquake resistant design) buildings or light weight buildings with lighter roofs in highly earthquake prone areas.

Impacts:

- ✓ Loss of many human and cattle lives.
- ✓ Damage and destruction of many human constructions, namely buildings, roads or highways, bridges, temples.
- ✓ Earthquake creates landslides which may block the highways, river channels, etc.
- ✓ Earthquake creates different types of avalanches which may kill hundreds of climbers, trekkers and Nepali guides at the Everest base camp in Nepal.

Earthquakes and continuous aftershocks destroyed the civil structures killing thousands of people and injured over twenty-two thousand people in Nepal and northern India

SPACE BASEED INPUTS FOR DISASTER MITIGATION AND MANAGEMENT AND FIELD WORKS RELATED TO DISASTER MANAGEMENT

- ➔ Natural disaster such as earthquakes , floods, drought, tornadoes, tropical cyclones, wildfire, tsunami, volcanic eruptions and landslides affects different parts of the world with varying intensities space and time.
- ➔ As per the statistics of International Strategy on Disaster Reduction there was an 18 percent rise in disasters during 2005 compared to 2004.
- ➔ This increase is mainly due to the rising numbers of floods and droughts that affect large swathes of population.
- ➔ About 157 million people were affected by disasters in 2005 Resulting in damages of about 159 billion USD in the world.
- ➔ India ranks as the second country among disaster prone countries in terms of populations affected.
- ➔ India experienced widespread floods, drought, landslides and earthquakes during 2005.
- ➔ Natural disasters are inevitable and it is almost impossible to fully recoup the damage caused by the disasters.
- ➔ But it is possible to minimize the potential risk by developing early disaster warning strategies, preparing and implementing development plans to provide resilience and to help in rehabilitation.
- ➔ Increased urbanization in developing countries and invasion of coastal river plain areas by agriculture, residential activities, etc., are some of the major factors that contribute to the increased vulnerability to natural hazards.

Disaster Management

- Disaster management refers to the comprehensive strategy in all phases of disaster for effectively reducing the impact of disaster.

- Disaster management cycle consists of the following different phases: **Forewarning, Relief & Rescue , Rehabilitation and Mitigation phases.**
- During the early warning phase of disaster , forecast will be issued in advance of occurrence of the disaster.
- Can be done to evacuate people and movable property.

Forewarning

- ❖ It is very important in the sense that the occurrence of event is known early so that planning can be done to evacuate people and movable property.
- ❖ Technical expertise and facilities are required to issue the forecast.
- ❖ The communication also plays an important role in collecting the required ground data in real time and also to disseminate the forecast and warning information.
- ❖ In case of flood, the occurrence of flood and its magnitude is forecasted using hydrological models or gauge correlation techniques.
- ❖ Based on the flood stage a flood warning is given for taking necessary action .
- ❖ The forecast details will be transmitted to the concerned department like state and district Administration, etc.
- ❖ The basic data requirements for floods in this phase will be meteorological and hydrological data.
- ❖ In case of cyclones, their movement can be monitored from formation stage over the oceans to till the landfall occurrence at frequent intervals.
- ❖ But the exact prediction is quite difficult with the available models.
- ❖ When a disaster event occurs the first and foremost activity that will be taken up with high priority is the relief and rescue.

- ❖ In case of a disaster occurrence, relief activity will be initiated to evacuate the people and movable property, organizing relief camps, air dropping of food and material, medical facilities, etc.

Relief & Rescue

- ❖ It phase is the most critical and actions have to be taken on the spot according to the situation.
- ❖ Timeliness, organizing resources and manpower are the essential components.
- ❖ The information required during this phase is extensive and critical since the actions have to race against time.
- ❖ Primary information will be on impact of the event, the extent of the area affected, location specific details, population affected, availability of resources for evacuation of the people & means of evacuation and quick assessment of damages.

Rehabilitation

- ❖ During the rehabilitation phase, the disaster victims have to be rehabilitated restoration of essential services, establishing communication and distribution of relief material.
- ❖ It will continue till the situation comes to normal. Actions have to be rehabilitated, restoration of essential services, establishing essential requirement at relief camps etc.
- ❖ The information required during the phase will be the extent of damage caused by the disaster, inventory of resources, collection and compilation of reports etc.
- ❖ In the mitigation phase long term and short measures will be planned for disaster mitigation.

- ❖ The involves preparation of master plans, hazard zonation and vulnerability analysis, location specific analysis of the disaster problem, modes and means available for disaster analysis including research, etc.
- ❖ With the lessons learnt in the past, suitable mitigation measures will be planned and executed.
- ❖ The type of information required will be mainly on the nature of the disaster.
- ❖ In the case of flood disaster mitigation, the information requirements will be, status of the existing structural and non-structural measures, severity of the flood problem, feasibility study of the suitable flood control measure etc.

Mitigation

- ❖ It is important in a way it reduces the impact of the disaster saving loss of life and property.
- ❖ A comprehensive disaster management system must allow to access many different kinds information at multiple levels at many points of time.
- ❖ Disaster information involves more than just data and several interconnecting steps are typically required to generate the types of action-oriented products that are needed by the disaster management community.
- ❖ The exact steps taken depend on the disaster phase and how time critical the need is.

Present SPACE Dataset

- ▲ Satellite remote sensing systems from their vantage position have unambiguously demonstrated their capability in providing vital information and services for disaster management
- ▲ The earth observation satellites provide comprehensive and multi temporal coverage of large areas in real time and at frequent intervals

- ▲ They have become valuable for continuous monitoring of atmospheric as well as surface parameters related to natural disasters
- ▲ Satellite communication capabilities fixed and mobile plays an vital role for effective communication, especially in data collection, distress alerting, position location and coordinating relief operations in the field
- ▲ Remote sensing technology provides a database indicating which area is potentially dangerous
- ▲ Using remote sensing data such as satellite imaginaries and aerial photos, allows to map the variability of terrain properties such as vegetation, water, geology, both in space and time
- ▲ Satellite image provide very useful environmental information

Indian case studies

- * Most of the Indian landmass are prone to several natural disasters with the East and west coast being affected by severe cyclones
- * Department of space, govt. of india has launched a major programme for providing space based inputs to the nation for disaster management
- * ISRO with space infrastructure comprising of Indian national satellite (INSAT) and Indian Remote sensing (IRS) series of satellites is uniquely placed to provide services related to disaster watch, warning dissemination, data collection, monitoring and assessment

Flood

- ✚ Floods are the most common and wide spread of all natural disasters
- ✚ One of the most important elements in flood disaster management is the availability of timely information for taking decisions and actions by the authorities
- ✚ The procured satellite data is analysed within a few hours and flood map will be generated showing flood inundated areas and the information is being furnished to the National Disaster Management Division..etc

- ✚ With the combination of satellites, it is possible to generate flood inundation information temporally and accurately in a scientific manner

Drought

- ✚ India is being an agrarian country and most of the population depends basically on the agriculture
- ✚ In india about 68% of total sown area of the country is drought prone
- ✚ Satellite sensors provide direct spatial information on vegetation stresses caused by drought conditions
- ✚ District wise detailed assessment of drought is being carried out for two states of AP, Karnataka using IRS WiFis/AWiFs , wich has a spatial resolution of 188m/56m and temporal revisit period of 5 days

Landslides

- ✚ The main contribution of satellite data is to provide the geological details, landuse etc in determining how the landslide occurs and what causes the failures
- ✚ GIS techniques are used increasingly for regional analysis and prediction
- ✚ Several digital data sets are typically used for such analysis
- ✚ This include the inventory of landslides
 - Seismic records
 - Large scale geological mapping
 - High resolution digital elevation data
 - Suitable high-resolution remote sensing data and aerial photographs
- ✚ This mapping procedure can be used to produce hazard risk maps that will assist in emergency preparedness planning and in making decisions regarding development and construction in areas prone to slope failure
- ✚ Current research has shown that airborne and satellite InSAR techniques are being used to produce detailed slope information

Earthquake

- ✚ the Indian sub-continent is subjected to varying degrees of earthquake hazard demonstrated by the fact more than 650 earthquakes having magnitude above 5 have been recorded during last century
- ✚ one of the basic elements in assessing seismic hazards is to recognize seismic sources that could affect the particular location at which the hazard is being evaluated
- ✚ these sources are often called seismo-tectonic sources

Forest fire

- ✚ Indian forest ecosystem especially deciduous forests and grasslands in India are prone to fires every year
- ✚ Forest fire can also emanate greenhouse gases aerosols and may be critical in the context of climate change
- ✚ The fire management calls the priority in India during summer as a key forest management
- ✚ Existing fire alert systems in the country mainly depends on the fire watchtowers information collected by guards and communicated through wireless..etc
- ✚ Rapid damage assessment and mitigation planning need efficient and reliable information support
- ✚ Satellite remote sensing with its synoptic and temporal coverage can augment the ground operations interms of fire detection, damage assessment and planning the mitigation in a time and cost effective manner

Indian forest fire responses and assessment system

- Under this system TERRA MODIS data based fire products will be generated everyday within 4 to 5 hours of the satellite ground ass

- DMPS OLS data acquired at different time periods will be provided by the forenoon of the next day
- MODIS and DMSP fire products indicating active fire locations
- At present all fire products are experimental products which are under validation
- These products are released to assess operational utilization and quality improvement

Existing gaps

- * EO community has arrived at a set of wish list having highly diverse specification for natural disaster management
- * The major feature of interest in spatial resolution, temporal resolution, spectral coverage, image size..etc

Spatial resolution

- * Panchromatic imagery with 1-3m resolution, multi- spectral imagery with 4m resolution and hyper spectral imagery with 8 m resolution
- * Radar imageries could be 3 to 100m

Swath

- * 4-40 km in optical imaging system
- * 20-500 km for radar imaging

Spectral coverage

200 channels hyper- spectral imagery and radar satellites to have full polarisation response function

Revisit

Less than 3 days with the ability to turn from side to side on demand towards decreasing the revisiting interval

Delivery time from acquisition to user

Imagery to be down linked in real time to ground stations located around the world

Capacity of stereo

In-tracking and cross-tracking stereoscopic capability using linear array imaging principle

Sensor position and altitude

Navigation of sensor to be autonomous via on-board performance using positioning sensors and attitude sensors

Imager type

“whisk-broom and push-broom” modes in optical satellites

Radar satellites

- ✓ To supply images with resolution from 3 to 1000m for swath from 20 to 500 km
- ✓ There are some gaps in the existing earth observation capabilities in capturing certain disaster events due to temporal and spatial domains
- ✓ The event like drought, crop pests/diseases, land degradation..etc are easy to capture by the exiting EO missions, while earthquake, cyclone and flood are difficult to capture in real time
- ✓ Observations of the attributes such as terrain features, ecological and socio economic status do provide the valuable information
- ✓ Limited number of EO satellites carrying moderate resolution sensors, currently in operational provide only infrequent coverage of tropical regions and always image at the same local time of day

- ✓ It is important to examine the sensors and platforms especially the spectral bands, ground resolution and revisit period requirements necessary to address not only the existing observation gaps but also work in synergy with EO missions, particularly the past/future EO missions.
- ✓ In 2D observational frame, spatial and temporal aspects of the events are to be captured appropriately.
- ✓ Capturing them in real time, both the appropriate spatial as well as temporal dimensions, holds the highest value of information.
- ✓ Later, each individual satellite covers a small proportion of the earth surface, a rapid response using high resolution satellites can only be achieved with several satellites operating simultaneously.
- ✓ With more advances in the space technology stored in future, with sophisticated sensors and more capabilities, it is possible for better management of natural disaster.

MAN MADE DISASTERS: CASE STUDIES

KOREA: CASE HISTORIES

- Infrastructure in Korea was built after the significant growth in the economy 1960.
- The problems caused by man-made disasters showed that disaster responses were not probably carried out because of the lack of prevention system or appropriate equipment.
- It is found that the laws related to man made disasters are very broad and they overlap across different government organizations.

KOREA: IMPROVEMENT PLANS

- * As the technology for human life has developed, the damage by traditional natural disasters such as droughts and floods has been reduced.

- * Man made disasters are defined by the federal act on the Disaster and Safety Management and compromise large scale accident defined by the presidential degree, including fire, collapse etc, .
- * These disaster were being administered by several government organizations India experienced 480 man made disasters during the period of 1990-2009.
- * Man made disasters constituted 62.2% of the total.
- * Improving mobile computing support for disaster response and recovery facilities better assessment of the damage caused to buildings and effective disaster response.
- * The design of reliable and scalable communication and information management system is necessary for coordinated and responses.
- * Partnership frameworks should be established to implement the sequential phases of prevention, preparedness, response and recovery for disaster management.

CAUSES OF MAN MADE DISASTERS

Fire accident

- ✧ Fire accidents including sealand in Hwaseong, subway in Daekoo and Hoof and restaurant in Incheon resulted in life and property losses.
- ✧ Subway fire accidents in Daekoo in feb 2003 resulted in the loss of 192 lifes, injuries to 148 people and property damages of \$40 million.
- ✧ The criminal in this accident, 50 years old man ignited a plastic bottle filled with oil and 12 passengers train was burned to its frame.
- ✧ On the day after the accident, Daekoo was proclaimed a special disaster area.
- ✧ Fire accident at the restaurant located on the fourth floor of a building in Incheon on October 30 1999, resulted in 57 deaths and 80 injuries.
- ✧ Most of the victims were high school students.

Collapse

- Collapses of infrastructure including buildings, bridges and dams caused by inappropriate design and construction, low level technology, aging, maintenance, etc.,.
- Sinhengju grand bridges collapsed due to inappropriate design and construction, supervision on July 31 1992.
 - ❖ Bridge was designed with incorrect spans of piers between two towers and constructed with incorrect continuous between the cable stayed bridge and the continuous bridge
 - ❖ The collapse was also induced by the inappropriate number and location of piers between the 2 towers
 - ❖ The collapse occurred at the almost completed stage of construction
 - ❖ This accident provided lessons on how the bridge needed to be carefully designed and constructed with allowable safety levels

Explosion

- ➔ Explosions caused by the explosion of phosphide gas, explosives and energy resulted in life and property losses
- ➔ Typical gas explosions in Korea were occurred in Seoul, Daekoo and Bucheon city
- ➔ A gas explosion on December 7, 1994 occurred in Seoul
 - The accident resulted in the loss of 12 lives, injuries to 170 people and 366 refugees from 127 residential buildings
 - After the accident the immediate response was not appropriately and systematically carried out because of low level of technology and insufficient equipment

➔ An explosion at the LPG station in Bucheon occurred on September 11, 1998

- Leaked gas ignited by unknown sources resulted in the explosion
- At that time the vent valve on the underground LPG tank was the vent valve was opened and emitted gaseous nitrogen
- The accident resulted in the death of one, 96 injuries and property damages of \$11 million

Traffic accident

- ❖ Traffic accident by car, railway, airplane and ships resulted in life and property losses
- ❖ In March 1993, as a train passed the Gupo station, it was derailed because the soft ground settlement caused by blasting loads near the railways during excavation work because the Korea Electric Power Corporation performed the construction work without permission from the National Railroad Administration
- ❖ The accident resulted in the losses of 78 lives and injuries to 198 people
- ❖ The crash of the Asian Airlines flight resulted in 66 deaths and injuries to 46 in July 1993

Environmental pollution

- Environmental pollution includes air, water and soil pollution
- Only water pollution has been a critical problem in Korea. One of the typical cases was phenol pollution in the Nakdong river, which occurred on March 14, 1991
- 30 tons of phenol leaked from a damaged phenol pipeline, infiltrated an intake station and then contaminated the water supply for the residents of Daekoo

- When the disasters occur, each organization should be responsible for assigned work and charged with respect to its responsibility
- Public activities and citizen education should be carried out in systematic ways with practical exercises

COASTAL FLOODING : STORM SURGE ASSESSMENT CASE STUDIES

- **Coastal flooding** occurs when normally dry, low-lying land is flooded by seawater.
- The extent of coastal flooding is a function of the elevation inland flood waters penetrate which is controlled by the topography of the coastal land exposed to flooding.
- The seawater can flood the land via from several different paths:

Coastal flooding is categorized in three levels:

- **Minor:** A slight amount of beach erosion will occur but no major damage is expected.
- **Moderate:** A fair amount of beach erosion will occur as well as damage to some homes and businesses.
- **Major:** Serious threat to life and property. Large-scale beach erosion will occur, numerous roads will be flooded, and many structures will be damaged. Citizens should review safety precautions and prepare to evacuate if necessary

Indonesia and Japan post-earthquake and tsunamis

- ✓ An earthquake of approximately magnitude 9.0 struck off the coast of Sumatra, Indonesia causing the massive tsunami throughout the Indian Ocean.
- ✓ This tsunami caused significant loss of human life, an estimate of 280,000 – 300,000 people has been reported and caused extensive damage to villages, towns, and cities and to the physical environment.
- ✓ The natural structures and habitats destroyed or damaged included coral reefs, mangroves, beaches, and seagrass beds.

The more recent earthquake and tsunami in Japan in March 2012 also clearly illustrates the destructive power of tsunamis and the turmoil of coastal flooding

Causes

Coastal flooding can result from a variety of different causes including storm surges created by storms like hurricanes and tropical cyclones, rising sea levels due to climate change and by tsunamis

Sea level rise

- The Intergovernmental Panel on Climate Change (IPCC) estimate global mean sea-level rise from 1990 to 2100 to be between nine and eighty eight centimetres.
- It is also predicted that with climate change there will be an increase in the intensity and frequency of storm events such as hurricanes.
- This suggests that coastal flooding from storm surges will become more frequent with sea level rise

Mitigation

- It has been said that one way to prevent significant flooding of coastal areas now and into the future is by reducing global sea level rise.

- This could be minimised by further reducing greenhouse gas emissions

Socio economic impact

- ✓ The coastal zone (the area both within 100 kilometres distance of the coast and 100 metres elevation of sea level) is home to a large and growing proportion of the global population.
- ✓ Over 50 percent of the global population and 65 percent of cities with populations over five million people are in the coastal zone.
- ✓ In addition to the significant number of people at risk of coastal flooding

Storms and storm surges

A storm surge, storm flood, tidal surge or storm tide is a coastal flood or tsunami-like phenomenon of rising water commonly associated with low pressure weather systems

Case studies of storm surges

- The deadliest storm surge on record was the 1970 Bhola cyclone, which killed up to 500,000 people in the area of the Bay of Bengal.
- The low-lying coast of the Bay of Bengal is particularly vulnerable to surges caused by tropical cyclones.
- The deadliest storm surge in the twenty-first century was caused by the Cyclone Nargis, which killed more than 138,000 people in Myanmar in May 2008.
- The next deadliest in this century was caused by the Typhoon Haiyan (Yolanda), which killed more than 6,000 people in the central Philippines in 2013 and resulted in economic losses estimated at \$14 billion (USD).

- The Galveston Hurricane of 1900, a Category 4 hurricane that struck Galveston, Texas, drove a devastating surge ashore; between 6,000 and 12,000 lives were lost, making it the deadliest natural disaster ever to strike the United States
- The highest storm tide noted in historical accounts was produced by the 1899 Cyclone Mahina, estimated at almost 44 ft (13 metres) at Bathurst Bay, Australia, but research published in 2000 concluded that the majority of this likely was wave run-up because of the steep coastal topography
- In the United States, one of the greatest recorded storm surges was generated by Hurricane Katrina on August 29, 2005, which produced a maximum storm surge of more than 28 ft (8 metres) in southern Mississippi, with a storm surge height of 27.8 ft (8.5 m) in Pass Christian.
- Another record storm surge occurred in this same area from Hurricane Camille in 1969, with a storm tide of 24.6 ft (7.5 m), also at Pass Christian.
- A storm surge of 14 ft (4.2 m) occurred in New York City during Hurricane Sandy in October 2012

Storm and storm surges

- Storms, including hurricanes and tropical cyclones, can cause flooding through storm surges which are waves significantly larger than normal.
- If a storm event coincides with the high astronomical tide, extensive flooding can occur. Storm surges involve three processes:
 1. wind setup
 2. barometric setup
 3. wave setup

- Winds blowing in an onshore direction (from the sea towards the land) can cause the water to 'pile up' against the coast; this is known as wind setup.
- Low atmospheric pressure is associated with storm systems and this tends to increase the surface sea level; this is barometric setup.
- Finally increased wave breaking height results in a higher water level in the surf zone, which is wave setup.
- These three processes interact to create waves that can overtop natural and engineered coastal protection structures thus penetrating seawater further inland than normal

Measuring surge

- ➔ Surge can be measured directly at coastal tidal stations as the difference between the forecast tide and the observed rise of water.
- ➔ Another method of measuring surge is by the deployment of pressure transducers along the coastline just ahead of an approaching tropical cyclone.
- ➔ This was first tested for Hurricane Rita in 2005.
- ➔ These types of sensors can be placed in locations that will be submerged and can accurately measure the height of water above them
- ➔ After surge from a cyclone has receded, teams of surveyors map high-water marks (HWM) on land, in a rigorous and detailed process that includes photographs and written descriptions of the marks.
- ➔ HWMs denote the location and elevation of flood waters from a storm event.
- ➔ When HWMs are analyzed, if the various components of the water height can be broken out so that the portion attributable to surge can be identified, then that mark can be classified as storm surge.

- ➔ Otherwise, it is classified as storm tide. HWMs on land are referenced to a vertical datum (a reference coordinate system).
- ➔ During evaluation, HWMs are divided into four categories based on the confidence in the mark; only HWMs evaluated as "excellent" are used by National Hurricane Center in post-storm analysis of the surge

Mitigation

- ➔ Although meteorological surveys alert about hurricanes or severe storms, in the areas where the risk of coastal flooding is particularly high, there are specific storm surge warnings.
- ➔ These have been implemented, for instance, in the Netherlands, Spain, the United States, and the United Kingdom
- ➔ A prophylactic method introduced after the North Sea Flood of 1953 is the construction of dams and storm-surge barriers (flood barriers).
- ➔ They are open and allow free passage, but close when the land is under threat of a storm surge.

CASE STUDIES: FLUVIAL AND PLUVIAL FLOODING

Pluvial flooding (Surface Flood)

- ✓ A pluvial, or surface water flood, is caused when heavy rainfall creates a flood event independent of an overflowing water body.
- ✓ One of the most common misconceptions about flood risk is that one must be located near a body of water to be at risk.
- ✓ Pluvial flooding debunks that myth, as it can happen in any urban area — even higher elevation areas that lie above coastal and river floodplains

- ✓ Pluvial flooding occurs when the amount of rainfall exceeds the capacity of urban storm water drainage systems or the ground to absorb it.
- ✓ This excess water flows overland, ponding in natural or man-made hollows and low-lying areas or behind obstructions.
- ✓ This occurs as a rapid response to intense rainfall before the flood waters eventually enter a piped or natural drainage system.
- ✓ This type of flooding is driven in particular by short, intense rain storms, such as that which occurred over the Dublin area in October 2011.

Fluvial (River Flood)

- ✓ Fluvial, or riverine flooding, occurs when excessive rainfall over an extended period of time causes a river to exceed its capacity.
- ✓ It can also be caused by heavy snow melt and ice jams.
- ✓ The damage from a river flood can be widespread as the overflow affects smaller rivers downstream, often causing dams and dikes to break

Study area

- Two main sewer pipes collect runoff from the north-west and the south-west upstream catchments and join in the area; joined by the local sewer network, the drainage system carries on towards the waste water treatment plant in the south-east, where a flap valve exists to prevent backwater from the river channel.
- The DTM with buildings was obtained from the LiDAR data, and resampled as 2m x 2m grid resolution for 2D overland flow modelling.

- The ground surface elevation varies from 83 m (areas next to the rivers) to 94 m (the roundabout in the west).
- The top elevation of levees along the River Aire was raised to 10 cm above 100 year flood level after a fluvial flooding event in 2000.
- Both pluvial and fluvial flooding conditions and their combinations were simulated by the coupled SIPSON/UIM model.
- The numerical modelling results were integrated into a GIS database and an analysis toolbox was built to identify the dominant factor that causes inundation.

METHODOLOGY

- ✓ The study investigates the effects of pluvial and fluvial flooding and their combinations in urban area by using an integrated sub-surface/surface numerical model (SIPSON/UIM; Chen et al., 2007).
- ✓ The 1D sewer network model SIPSON (Djordjević et al., 2005) is used for calculating the rainfallrunoff hydrographs and the flow conditions in the drainage network, whereas the 2D overland flow model UIM (Chen et al., 2005) is employed for the surface flow simulation.
- ✓ SIPSON consists of two components, the hydrological and the hydraulic models.
- ✓ The hydrological model (Radojković and Maksimović, 1984) computes the rainfall-runoff hydrographs of subcatchments to be input as manhole inflows in the hydraulic model.
- ✓ The hydraulic model simulates the flow in drainage networks by simultaneously solving continuity equations for network manholes, energy equations for manholes and pipe/channel ends, the complete Saint Venant

equations for flow in conduits and streets, and equations for other link types (pumps, weirs, etc.).

- ✓ UIM is a 2-D non-inertia model derived from the St. Venant equations for overland flow simulations of alluvial plains with mild natural topography.
 - ✓ The inertial terms are neglected by assuming the acceleration terms of water flow on the land surface are relatively small compared to gravitation and friction terms.
 - ✓ The functions of hydraulic devices, such as pumping station, weir, orifice and gate, are also implemented by adopting the respective equations.
 - ✓ The modelling results were integrated into a GIS database for further analysis.
 - ✓ The individual and composite flooding extents were overlapped and compared to each other scenarios
-
- ❖ The numerical modelling study combined a matrix of pluvial rainfall events with fluvial flooding scenarios.
 - ❖ The results were analysed to identify the dominating driver of flooding in different parts of the case study, providing better understanding to flood risk management.

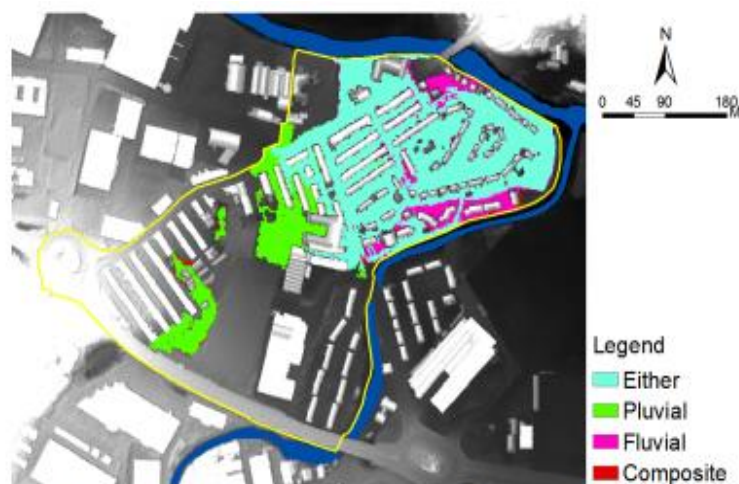


Figure 5. The categorised main driver of flooding.

