UNIT-1 UNDERSTANDING DISASTER

What is disaster?

Disaster, whether natural or anthropo-genic are sudden adverse unfortunate extreme events or hazards which cause greate damage to human being as well as plants & animals.

Disaster occur rapidly, instantaneously and indiscriminately A disaster is an unusual and dramatic event that, in a relatively short time span, causes enough death & destruction as to disrupt the normal pattern of living community, region or society.

According to World Health Organization, "A disaster is an act of nature or an act of man which is or treatens to be of sufficient severity and magnitude to warrant emergency assistance."

Characteristics Features of Disaster :—

- They are natural or man-made hazards.
- They occur rapidly, instaneously and indiscriminately.
- They are always viewed in terms of human being i.e. severe damage to human life and property.
- The intensity of disaster is weighed in terms of the quantum of damages done to the human society.
- They are such uncontrollable extreme event that disrupt social structure and impair essential functions which are necessary to support human life system.
- They cause several socio economic and health problem etc.

Hazard

Hazards are those events which have potential to cause the loss of human life and property, social and economic disruption and environmental degradation.
A hazard is a potential for a disaster. A hazard becomes a disaster when it heats an area affecting the normal life system.
for example;
If a hazard like a cyclone hits an unpopulated area, say an unpopulated coast, it need not be considered as a disaster. Howevet, it will be considered a disaster if life and property are seriously damaged.

Characteristics features of Hazard;

1. Hazard are natural or man-made extreme events.
2. Hazard are physical events or causes or processes of disasters.
3. Hazards have potential for damaging different forms of life mainly human life.
4. Hazards represent latent conditions for future threats to all types of biota.
5. Hazards are of varying origins of natural origin or of anthropogenic origin.
6. Hazards may or may not become disasters etc.

Difference between Disaster and Hazards;

Hazards	Disasters
1. Hazard refers to danger-ous, risky situation which have enough potential to cause a threat to human life.	2. Disasters are an event that completely causes damage to human life and property.

2. Hazards have less critical consequences.	2. Disasters have more critical consequences.
3. Takes it full shape after a series of events which might have led it to happen.	3. Often happens in a short time causing more severe effects.
4. Hazards usually have spacial warnings designed to protect them from becoming a disaster.	4. Disasters are the outcomes of hazards that occur due to ignoring warnings and warning sign.

Hazard Classification

Hazard can be classified on different basis as follows;-

(A) On the basis of speed of occurrence

(i) Slow on-set hazards
(eg. drought, sea level changes, global warmings etc).

(ii) Rapid on-set hazards
(eg. volcanic eruption and lava flow, earthquakes, tsunamis, tornado etc).

(B) On the basis of Hazard/Disaster duration

(i) Short duration hazards/disaster
(eg. tornado, avalanche, lava flow, landslides, earthquake

(ii) Long duration hazards/disaster
(eg. floods, droughts etc)

(C) On the basis of primary causative factors

(1.) Tectonic Hazards
(eg. earthquakes, volcanic eruptions, tsunamis, landslides lava flows etc).

(2.) Atmospheric / Meteorological hazards

(a) Abnormal or frequent hazards,

(i) Cyclones
(ii) Hurricanes
(iii) Typhoons
(iv) Tornadoes
(v) Lightning
(vi) Hailstrom
(vii) Dust strom
(viii) Snow strom

(b) Cumulative atmospheric hazards

(i) floods
(ii) Doughts
(iii) Heat waves
(iv) Cold waves

(3.) Biological / Health related hazards

(a) Eutrophication - Eutrophication, the gradual increase in the concentration of phosphorus, nitrogen and other plant nutrients in an aging aquatic ecosystem such as a lake.

(b) Epidemics & Pandemics;-

Epidemics means a large number of people or animals suffering from the same disease at the same time.

Pandemics means a disease that spreads over a whole country or the whole world.

(4.) Technological Hazards :-

(a) Transportation Hazards (eg. rail, road & aviation accidents)

(b) Nuclear Plants Failures (eg. Chernobyl nuclear plant disaster)

(c) Infrastructure Hazards (eg. power failures, tele communication systems failure, computer network failures, water supply and sewer system failures etc).

(d) Dam Failures (Breaches)

(5.) Industrial Hazards (eg. storage accidents such as Bhopal gas° tragedy in 1984, fireworks accidents)

(6) Terrorism Hazards (eg separatist terrorism, religious terrorism, state's sponsored terror-ism).

(7.) Wars and Conflicts Related Hazards.

Vulnerability

Vulnerability denoted the characteristics and circumstances of an individual, community or area that may be subjected to harm from a hazardous situation.

It determines to what extent and depth the individual community and area may be impacted or effected by a disaster.

Vulnerability comes from many factors physical, social, economic and environmental.

Vulnerability is also time-based and does not remains constant over long periods of time.

In a disaster situation, the vulnerable population includes the poor, the elderly woman and children and the disabled. In general, they are most affected.

Vulnerable areas are those which are very close to the disaster site. In the case of a blast, assets and people living or present near the site of the blast are most seriously affected. People far off from the area are much less affected.

Factors of Vulnerability :-

1. Poorly designed and maintained infrastructure.
2. Inadequate safety awareness and safety measures for assets.
3. Lack of awareness and adequate information about hazards and risks.
4. Inappropriate management of risks identified and lack of preparedness to face hazards.
5. Poor or inadequate management of resources & environment.

According to UNISDR vulnerability is of four types :-

1. Physical Vulnerability

It may be determined by aspects such as population density levels, remoteness of a settlement, the site, design and materials used for critical infrastructure and for housing.

Example :- 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, organisations and societies to withstand adverse impact of hazards due to characteristics inherent in social interactions, institutions and systems of cultural values.

Example :- When flood occur, some citizens, such as children, elderly and differently-abled 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 sturdy structures in their homes and put other engineering measures in place to protect themselves from being negatively impacted by disasters.

Example :- Poorer families may live in low-lying slum areas because they cannot afford to live in safer (more expensive) areas. They are more vulnerability when a flood occurs and their belongings or even their homes get washed away.

4. Environmental Vulnerability:

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

Example: People living in hilly areas becomes vulnerable because of environmental degradation. Their habitats have to necessarily be on hill slopes due to the terrain features. Deforestation and cutting of trees on hill slopes makes them vulnerable to hazards from landslides.

$$\text{Risk} = \frac{\text{Hazard} \times \text{Vulnerability}}{\text{Capacity}}$$

Disaster Risk

In general, risk is defined as "the combination of probability of an event and its negative consequences." Risk is usually associated with the degree to which human cannot cope (lack of capacity) with a particular situation (e.g. natural hazard)

The term disaster risk therefore refers to the potential (do not actual and realised) disaster losses, in lives, health status, livelihoods assets and services, which could occur in a particular community or society over some specified future time period.

Disaster risk is the product of the possible damage caused by a hazard due to the vulnerability.

Risk in general, considers the probability of harmful consequences in terms of

i) Loss of life
ii) Injuries to people
iii). Disabilities due to injuries
iv). loss of livelihood,
v). loss of property of individuals and community.
vi). Damage to essential services
vii). Loss due to stoppage
viii). Damage to the environment and ecosystem.

Capacity

Capacity can be defined as the ability of a community to cope with a disaster.

This will include the resources available to the community their strengths and the mechanisms in place to deal with the disaster.

In the aftermath of a disaster, many lives are lost, people lose their homes, their livelihood and other infrastructure and services. The capacity of the community will be visible in the way the community has prepared itself for such an eventuality, the way they mitigate the sufferings of people and cope with losses of individuals and the community.

Disaster Management

Disaster management is a planning to minimize the adverse effects of a disaster in a concerned area and to restore normal life of the people therein.

Disaster management is planned steps taken by an organization or a society or a country to lessen the adverse effects of disasters and to bring back the business continuity of the people or say to restore the normal routine work of the socity.

The objectives of disaster management can thus stated

1. To undertake all preventive measures including control over developmental activities to limit damage caused by disasters.
2. To undertake hazard mapping and risk analysis for disaster preparedness.

3. To train personnel and set up disaster management system.
4. To identify government and private agencies like NGOs in hazard prone areas and ensure coordinated action by all agencies.
5. To plan and set up mechanisms to deal with emergency situations, plan logistics of operation.
6. To ensure that all systems set up are in an operational condition and frequently and check their readiness.

UNIT-2 Types, Trends, Causes, Consequences and control of Disaster

Classification of Disaster

1. Natural Disaster
   - Geological Disaster; Earthquake, Landslides, Tsunami.
   - Meteorological Disaster; Cyclones, Lightning, Thunder-Storms, Hail storms.
   - Climatological Disaster; Droughts, Cold and Heat Waves.
   - Hydrological Disaster; Floods, Flash floods.
   - Biological Disaster; Epidemics, Pest attacks.
2. Man-induced or Anthropogenic Disaster
   - Technological Disaster; Industrial Accidents, Structural collapse, Power outages, Fires.
   - Sociological Disaster; Arson, Looting Strikes/Group clashes, Bomb blasts, Terror strikes, War.
   - Chemical Disaster; Gas leaks, Blasts Oil spills, Acid rains radiation/Nuclear.
   - Transport-Related; Road, Rail Aircraft, Acid rains.

Natural Disasters

These disasters are caused by natural factors like geographical or climatic change.

Natural disasters cannot be controlled by human.

Natural disasters are unpreventable.

This type of disasters can occur anywhere in the world.

Natural disasters can have long-term effects on the environment.

For example; Floods
Tsunami
Earthquake.

Man-made Disasters

These disasters are caused by human negligiance and wrong activities.
Man-made disasters can be controlled by humans.
Man-made disasters are often preventable.
This type of disasters is often localized to specific areas.
Man-made disasters can have long-term effects on social and economic conditions.
Example; War, Nuclear Attack, Bio-chemical Attack.

Geological Disasters

Geological disasters or Geophysical disasters are calamities caused by geological processes, shifts in tectonic plates seismic activity and other factors are among the reasons. Examples are earthquakes, volcanoes, landslides, avalanches etc.

Hydrological Disasters

Hydrological disasters are caused by a sudden change in the quantity or movement in earths water soorces.
Examples are floods and tsunamis.

Meteorological Disasters

Disasters generated by extreme wheather conditions are known as meterological disasters. Such disasters are normally related to unexpected and adverse changes in the weather or weather-forming means.
Excessive heat, extreme rainfall and heavy winds negatively affecting the earths atmosphere and inducing death or destruction are labeled as meteorological disasters.
Some of the common meteorological disasters areblizzards, hailstorms and droughts.

Geological Disaster

Geological disasters or geophysical disasters are calamities caused by geological processes, shifts in tectonic plates, seismic activity and other factors are among the reasons. Examples are earthquakes, landslides, tsunami etc.

Earthquakes

An earthquakes, also known as a quake or tremor, is a natural disaster with the ability to impose considerable damage.

An earthquake is a motion of the ground surface, ranging from a faint tremor to a wild motion capable of shaking building apart and causing gaping fissures (a long deep crack in the earth) to open in the ground.

The term earthquake in a general sense, is used to describe any seismic event that generates seismic waves. This may be due to natural or man made causes. The most common origin of earthquakes is from the movement of large land masses across geological faults.

Causes of Earthquakes :-

The most common origin of earthquakes is from the movement of large land masses across the geological faults.

Although the Earth looks like a pretty solid place from the surface, it's actually extremely active just below the surface. The earth is made of four basic layers: a solid crust, a hot nearly solid mantle, a liquid outer core and a solid inner core.

The solid crust and top, stiff layer of the mantle make up a region called lithosphere. The lithosphere

isn't a continuous piece that wraps around the wh
earth like an eggshell. It is atually made up of giant
puzzle pieces called tectonic plates.

Tectonic plates are constantly shifting as they drift around
on the viscous, or slowly flowing, mantle layer below.
The tendency to move is prevented by various obstructions
on either plates. The tendency of one plate to move
over another is halted by obstructions and this accum-
-ulates enormous amount of elastic strain energy.
The slides of the fault plane can move smoothly only if
there are no obstructions and the movement is smooth
without any seismic effect.
When the movement takes place after sufficient storage
of elastic strain energy, there is sudden release of
this energy creating seismic waves.
The propagation of seismic waves causes ground motion
over a wide area around the epicenter.
This can cause collapse of buildings and bridges,
landslides, breach of dams and secondary effects
like death due to falling debris, floods etc.

The earthquake is a form of energy of wave motion
transmitted through the surface layer of the earth
in the widening surface circles from a point of
sudden energy release, the 'focus'.

The point where the initial rupture takes place is called the hypocentre or focus.

Normally the epicentre of an earthquake is the point on surface of Earth directly above the focus.

The focus may be shallow or deep.

When the focus is more than 300 km below the surface it is called a deep earthquakes, if the depth is less than 60 km, it is called shallow earthquake.

A shallow focus may cause for surface ruptures.

Seismic Waves

Seismic Waves are the vibration generated by an earthquake, explosion or similar energetic source and propagated within the Earth or along its surface.

Seismographs record the amplitude and frequency of seismic waves and yield information about the earth and its subsurface structure.

Types of Seismic Waves;

- Body Waves
  - Primary Waves (P waves)
  - Secondary Waves (S-Waves)
- Surface Waves
  - Love Waves (L Waves)
  - Rayleigh Waves (R Waves)

Body Waves

These waves are travelled within the earth.
Body waves are faster than surface waves and hence they are the first to be detected on a seismograph.

Primary (P) Waves :

These are compressional waves which cause the particles of rock to vibrate in the longitudinal direction.
The P waves travel fastest, therefore they reach a seismic station first.
Their velocity is 1.7 times than that of S-waves.
They pass through solids, liquids as well as gaseous materials.

Secondary (S) waves

These are shear waves which are transverse in nature.
These can only pass through solids and do not travel through the liquid outer core of the Earth.

Surface Waves

When P waves and S waves reach and Earth's surface they are transformed into surface waves.

Love Waves - They are transverse in nature and their velocity is much less than the P & S waves.

Rayleigh Waves - Rayleigh waves also moves on the surface and their movement is circular in motion as they move through the Earth.

Measurement of Earthquakes

The instrument used to measure the earthquake is known as "seismograph".

It uses two different scales.

1. Mercalli scale (In terms of intensity)
2. Richter scale (In terms of magnitude)

Mercalli Scale

- This scale represents the intensity of earthquake by analysing the aftereffects like how many people felt it, how much distruction occured.
- The range of intensity is from 1-12.

Richter Scale

- This scale represents the magnitude of the earthquake. Magnitude is expressed in absolute numbers from 1-10.
- Richter scale is used to find the amount of energy librated during earthquake.

Qn. Which one of the following instrument is used to measure the magnitude of earthquake?

✓a) Seismograph b) Mercelli c) Richter d) None of these

Qn. Which one of following scale is used to measure the intensity of earthquack?

a) Seismograph ✓b) Mercelli c) Richter d) None of these

Qn. Which one of the following scale is used to measure the magnitude of earthquake?

a) Seismograph b) Mercelli ✓c) Richter d) None of these

Main causes of earthquakes :-

1. Volcanic Eruptions ;

Earthquakes can occur as a result of volcanic activity, When molten lava pushes its way to the surface, it can cause movements in the earth's crust, generating seismic waves.

2. Tectonic Movements ;

The movements of tectonic plates which make up the earth's surface is major cause of earthquakes.

3. Geological Faults ;

Geological faults occur's when there is displacement of rocks along a fault line. When the rock moves along the fault line suddenly release accumulated stress & move, it results in tectonic earthquakes.

4. Man made activity, like dam construction, Nuclear explosion etc can also contribute to an earthquake.

5. Some minor causes of earthquakes include Landslides, Avalanches and the collapse of heavy rocks.

Effects of Disaster (Earthquakes) :-

- Earthquake cause damage to buildings, bridges, roads & other man-made structures.
- Earthquake can trigger secondary hazard such as fires and hazardous material spills.
- In areas with steep slopes or unstable terrain, earthquakes can trigger landslides and avalanches.
- Under earthquake can generate tsunamis, particularly those occuring along tectonic plate boundary.

Measure steps for Earthquake disaster reduction and management

The effective measures of earthquake disaster reduction & management are as follows:-

1. Make survey & mapping of seismic hazard zones.
2. To avoid the human settlements in the high earthquake risk zone.
3. To follow earthquake resistant architec-tural designs for the construction of buildings.
4. To use building materials of high quality and strength.
5. To stop the construction of high rise buildings in earthquake prone areas.
6. To restrict the groundwater mining to avoid larger cavities below the ground surface which may weaken the foundations of buildings.
7. To restrict urban growth in the hilly areas having high earthquake vulnerability risk.
8. Public awareness and training programmes about coping with earthquake disasters.
9. To stop deforestation and massive digging in the high seismic zones of hill regions etc.

Landslides

A landslide is a geological event in which a mass of rock, soil, or debris moves down a slope, often triggered by various factors such as heavy rainfall, earthquakes, volcanic activity, human activities or changes in the natural environment.

Landslides can occur on hills, mountains coastal cliffs, or any steep terrain where gravity overcomes the strength and stability of the slope material.

Causes of Landslides

1. Heavy Rainfall : Prolonged or intense rainfall can saturate the soil, reducing its stability and causing slop failure
2. Earthquakes : Ground shaking during earthquakes can disturb the balance of forces on a slope, triggering landslides.
3. Volcanic Activity : Volcanic eruptions can cause landslides by displacing large volumes of material or by creating unstable conditions on slopes.
4. Human Activities : Human-induced changes to the landscape, such construction, mining, deforestation or irrigation, can alter slope stability and increase the risk of landslides.
5. Geological Factors: Geological conditions such as the presence of weak or loose materials, steep slopes or faults can influence landslide occurrence.

Adverse effects of Landslide;

The adverse impacts of landslides are manifold ranging from human casualities to socio-economic effects as follows:

1. human casualties,
2. damage to infrastructure,
3. damage to settlements, roads and railroads,
4. Agricultural loss - loss of farms and crops,
5. Silting of lakes, ponds and tanks,
6. Overflow of rivers and flash floods,
7. economic loss etc.

Control measures of Landslides:

1. Early Warning system:- Improved weathe forecasting & early warning systems were estabilished to provide timely alerts about extreme rainfall events and potential land slide hazards.
2. Infrastructure development:- Efforts were made to rebuilt and reinforce critical infrastructure such as roads, bridges, and buildings to withstand potential landslides impact.
3. Land-use planning and regulation:- Strict land-use planning regulations where enforced to prohibit or restrict construction in landslide-prone areas.
4. Rehabilitation and livelihood support:- Rehabilitation programs were initiated to support the affected communities, providing assistance in rebuilding their homes and livelihoods.
5. Environmental conseration:- Efforts were made to promote substainable practices and the restoration of degraded landscapes.

Flood

Flood simply means immersion of extensive land area with water for several days in continuation.

A flood is an overflow of water that submerges land which is usually meant to be dry.

Flood which is defined as submerging of areas which are otherwise dry, can happen due to many reasons:

1. Water bodies like lakes and rivers overflowing their banks due to heavy inflow of water from catchment areas;

2. After heavy rainfall in the area, land getting flooded due to insufficient run off from drains and other obstruct
3. Breaches in dams or release of extreme water from dam
4. Waterways getting reduced due to silting or dumping of debris in them, normal water flow not possible leading to flooding.

Causes of flood;

1. Heavy rainfall :- Prolonged or intence rainfall can lead to excessive runoff, overwhelming drainage system and causing rivers and streams to overflow their banks.
2. Snowmelt :- During warmer months, melting snow can add substantial amounts of water to river and steams resulting in increased water levels and potential flooding.
3. Storm Surges :- Tropical cyclones or hurricanes, particularly when they make landfall, can generate strom surges, which are large ocean waves that flood coastal areas.
4. Dam Failures :- The failure of dams, which are designed to control water flow, can result in sudden and severe flooding downstream.

Impacts of Floods;

1. Loss of Life and injuries :- Flood can cause casualities and injuries, particularly when people are caught off guard or unable to evacuate in time.
2. Property damage :- Flood water can damage or destroy homes, buildings, infrastructure and personal belongings, resulting in significant economic losses.

3. Displacement and disruption :- Floods can force people to evacuate their homes and temporarily relocate to shelters or other areas. The disruption of transportation utilities, and services can severely impact daily life and economic activities.

4. Environmental Damage :- Floods can cause soil erosion, sedimentation, and contamination of water bodies, leading to ecological damage and the loss of habitats for plants and animals.

5. Health Risks :- Floodwaters may be contaminated with pollutants, sewage or harmful substances, increasing the risk of waterborne deseases and public health emergencies.

6. Socio-economic consequences :- Floods can have long-term social and economic impact including loss of livelihoods, increased poverty and strain on government resources forrecovery and rehabilitation efforts.

Preventive measures :-

1. Constructing and maintaining effective flood control infrastructure such as dams, lakes, and flood walls.
2. Implementing land use planning measures that consider flood risk and avoid building in flood-prone areas.
3. Developing and improving early warning systems to provide timely alerts to at risk communities.
4. Promoting community preparedness, including emergency resbonce training and evacuation plans.

5. Implementing effective urban drainage systems and storm water management practices.
6. Protecting and restoring natural floodplains and wetlands, which can acts as natural buffers against flooding.
7. Enhancing climate change adaptation strategis to address the increasing frequency and severity of floods.

Drought

Drought is a prolonged period of below-average precipitation or water availability in a particular region resulting in water scarcity, reduced soil moinsture and decreased water levels in rivers, lakes and groundwater.

Droughts can have significant impacts on agriculture ecosystems, watersupplies, and communities, leading to crop failures, food shortags and environmental degradation.

Causes of drought;

1. Natural climate variability :— Drought can be influenced by natural climate variations, such as El Niño and La Niña events. These phenomena can alter weather patterns and lead to prolonged dry condition in certain regions.
2. Changes in ocean temperature :— Variations in sea surface temperatures can influence weather patterns and contribute to drough conditions.

3. High Temperature :- High temperatures and heat waves can exacerbate drought conditions by increasing evaporation rates, further depleting soil moisture and water source.

4. Rainfall Deficiency :- The most common cause of drought is a prolonged period of below-average rainfall. Insufficient precipitation leads to soil moisture deficits, reduced water availability and a decline in water sources.

5 Deforestation and Land use changes :- Human activities like deforestation, land clearing and urbanization can alter the land's surface characteristics, leading to changes in local climate patterns and precipitation distribution

Impacts of drought :-

1. Water scarcity :- Drought reduces the availability of water for drinking, agriculture and industrial purposes.
2. Crop failure :- In-sufficient rainfall can lead to crop looses, impacting food production and increasing food prices.
3. Livestock and Wildlife :- Drought conditions result in inadequate grazing land and water sources, affecting livestock and wildlife populations.
4. Ecosystem Disruption :- Drought disturbs natural habitats contributing to decline of plant and animal species.
5. Economic losses :- Drought can cause economic downturns, especially in agriculture-department regions, leading to job losses and reduced income.
6. Water quality issue :- Drought can cause economic, Lower water level can lead to higher concentrations of pollutants and reduced water quality

7. Increased Fire Risk :- Dry conditions increase the likelihood of wildfires, endangering lives, property and ecosystems.

Prevention and Control Measures;

1. Drought Monitoring and early warning systems :- Implementing advanced meteorological monitoring and forecasting can help anticipated drought conditions, enabling early warning systems to be activated.

2. Water conservation and efficiency :- Encourage water saving practices such as efficient irrigation techniques, water recycling and public awareness campaigns.

3. Diversification of water source :- Developing alternative water sources like rainwater harvesting, desalination, and water recycling reduces reliances on traditional source.

4. Efficient agriculture practices :- Promote the use of drought - resistant crops precision agriculture techniques and efficient water management in faming.

5. Land and Forest Management :- Implement sustainable land management practices, such as afforestation, reforestation and erosion control measures to maintain soil moisture and prevent desertification.

6. Drought Contingency Planning :- Government and communities should develop and implement drought preparedness plans, including water rationing. Crop diversification and emergency responce strategies.

Fires

→ Fire refers to uncontrolled and destructive that spread rapidly, causing extensive damage to property, ecosystems, and human lives.

→ Fires can occur naturally as wildfires or result from human activities, such an industrial accidents, arson or improper handelling of flammable materials.

Occurances and types of fires :-

1. Urban Fires :- Urban fire refer to fires that occur in densely populated areas, usually cities or towns. These fires can be caused by electrical faults, gas leaks, industrial accidents or arson. Urban fires pose significant challenges for firefighting and rescue efforts due to the the density of buildings and infrastructure.
2. Industrial Fires :- Industrial fire can occur in factories warehouses refineries and other industrial facilities. These fires often involve hazardous materials, chemical or combustible substances, posing additional risks to human health and the environment.

Forest Fire

A forest fire also known as wildfire is an uncontrolled combustion that spreads rapidly through forest areas or other vegetation-covered lands.

Forest fires can occur naturally, but they are often caused by human activities, such as negligence, arson or accidents.

It involves the combustion and burning of trees, shrubs, grasses and other vegetation, often with significant intensity and destructive effects.

Causes of Forest Fire :-

Natural Causes :-

1. Lightning Strikes :- Lightning is a natural cause of forest fires especially in region with frequent thunderstorms.

2. Volcanic Activities :- Volcanic eruptions can lead to the outbreak of forest fires. Lava flows and hot ash can ignite vegetation, causing fires to spread rapidly.

Human causes :-

1. Unattended Campfires :- Campfires that are left unattended or not propely extinguished can escape control and ignite nearby vegetation. Sparks from the fire can be carried by wind, igniting surrounding fuel sources.

2. Discarded Cigarettes :- Cigarette butts thrown carelessly in forested areas can smolder and ignite dry vegetation, starting a fire.

3. Burning Debris :- Improper disposal of burning debris, such as agricultural waste or yard trimmings, can result in forest fires. The fire can quickly spread from the burning debris to surrounding vegetation.

4. Arson :- Deliberate acts of setting fires with malicious intent, also known as arson, can cause devastating forest fires.

5. Equipment Sparks :- Activities such as welding, or machinery operation in dry and flammable areas can generate sparks that can ignite nearby vegetation if proper precautions are not taken.

Impacts of forest fire

A Ecological Impacts :-

1. Habitat Destruction: Forest fires can destroy habitats, including trees, plant and understory vegetation, leading to the displacement of wildlife species.
2. Changes in succession:- Forest fires can disrup the natural process of ecological succession, altering the pattern of plant regeneration and community composition. This can lead to changes in the structure and function of ecosystem, affecting nutrient cycling, soil fertility and overall ecosystem health.
3. Loss of Biodiversity :- Intense fires can eliminate or reduce populations of plant and animal species, especially those that are unable to quickly recover or adapt to the changed conditions. This can result in a loss of biodiversity and negatively impact the balance of ecosystems.

B. Human Impacts :-

1. Loss of Lives and injuries :- Forest fires can pose direct risks to human lives, especially for fire-fighters and people living in affected areas. The inhalation of smoke burns and other fire-related injuries can result in casualties and long-term health effects.
2. Property Damage:- Forest fires can cause extensive damage to homes, infrastructure and properties in their path. Structures in the fire's vicinity can be engulfed, leading to the loss of homes, businesses and personal belonginge.

3. Displacement and Disruption:- Communities of forest fire may be forced to evacuate, resulting in temporary or long-term displacement. Fires can disrupt daily activities, including transportation, schools and essential services.

C. Climate Impacts

1. Forest fires release significant amounts of carbon dioxide and other greenhouse gases into the atmosphere. This contributes to the greenhouse effect and climate change.

2. Forests act as vital carbon sinks, absorbing and storing carbon dioxide from the atmosphere. When forests are destroyed by fires, the carbon dioxide stored in trees and vegetation is released back into the atmosphere reducing the capacity of forests to sequester carbon and mitigate climate change.

Cyclone

A cyclone is a large, rotating storm system with low pressure at its center.

A cyclone is a large air mass that rotates around a strong center of low atmospheric pressure, counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere as viewed from above.

Cyclones can cause a variety of hazards, including strong winds, storm surges and heavy rainfall.

Formation of Cyclones;

1. Formation and Initial Development stage

A warm sea with abundant and turbulent transfer of water vapour.

Atmospheric instability.

2. Mature Phase

Air rises and tends to spread out at the tropopause level.

Air warms up by compression and a warm 'Eye' is generated.

3. Modification and Decay

Cyclone begins to weaken as its source of warm moist air begins to ebb, or is abruptly cut off.

Causes of Cyclones;

1. Warm ocean Water: Cyclones form over warm tropical or subtropical ocean waters with a sea surface temperature exceeding 26.5°C (80°F), providing energy and moisture for their formation and intensification.
2. Climate Change: Rising sea surface temperatures provide more energy to fuel cyclones, allowing them to intensify more quickly and become more powerful.
3. Sea Level Rise: Higher sea levels means that storm surges can penetrate farther inland, causing more extensive coastal flooding and damage.
4. Charging Wind Patterns: Changes in atmospheric circulation patterns can steer cyclones towards more volnerable areas and also contribute to their intensification.

5. Monsoon Variability : The indian ocean dipole and El-Niño-Southern oscillation (ENSO) can affect monsoon patterns, which in turn can influence cyclone development.

Impact of cyclone:

1. Strong Winds :- Cyclones are characterized by powerful winds can reach speeds exceeding 119 km/hr that can cause extensive damage to buildings, infrastructure and vegetation.

2. Heavy rainfall and flooding :- Cyclones brings intense rainfall, which can lead to flash floods and river flooding. The heavy precipitation can cause landslides, damage crops, and disrupt water and sanitation systems, increasing the risks of water-borne diseases.

3. Strom surge :- It is a costal flood or rise in sea level caused by the strong winds and low atmospheric pressure of a cyclone. It can inundate coastal areas, erode shorelines and result in significant damage and loss of life.

Classification of cyclones:

1. Tropical cyclones : Develop in the region between the tropics of capricorn and cancer. They are large scale weather systems developing over tropical or subtropical waters, where they get organized into surfa wind circulation.

2. Extra tropical cyclones occurs in temperate zones and high latitude regions, though they are known to originate in the Polar regions.

Safety Measures for Cyclones

1. Early Warning system:

Meteorological agencies monitor and track cyclones using satellites weather radar, and other tools. Timely warnings and alerts are crucial for providing advance notice to people in the affected areas.

2. Evacuation Plans:

Local authorities develop evacuation plans to relocate residents from high risks areas to safer locations. This includes identifying evacuation routes, establishing shelters and organizing transportation,

3. Infrastructure preparedness:

Constructing buildings and infrastructure that are designed to withstand cyclonic winds are storm surge can help minimize damage. Strengthening roofs windows doors and ensuring proper drainage systems can also be effected.

4. Community awareness and education:

Educating community about cyclones, their impacts and necessary safety measures can help people understand the risks and take appropriate actions. This includes teaching individuals how to secure their property, stocks essential suppliers and develop personal emergency plans.

5. Relief and recovery operations:

Adequate preparations should be made for post cyclone relief and recovery operations including providing medical assistance restoring essential services and facilitating the distribution of food water and other things.

Tsunami

→ The term tsunami generally refers to enormous amount of water rising from the sea and flooding coastal areas.

→ A tsunami is a series of very long wavelength waves in large water bodies like seas or ocean caused by a major distribution above or below the water surface or due to the displacement of a large volume of water.

→ The word tsunami comprises the Japanese words "tsu" means harbour and "nami" means wave.

→ The cause of the tsunami may be a submarine earthquake, volcanic eruption, under water blasts, nuclear explosion under the sea etc.

Causes of Tsunami :—

1. Undersea powerful earthquake
   Even exceeding 7.0 magnitude of richter scale.
2. Undersea massive landslides
   Caused by sudden tectonic movements displace seawater upward which generates tsunamis.
3. Explosive volcanic eruptions
   In the sea floor or on islands also generate powerful tsunami waves.
4. Nuclear Explosion under the sea.

Impact of Tsunami :—

1. The powerful tsunami waves can destroy physical structures and infrastructure as houses, buildings, roads and rail networks, communication systems, small ships and fishing boats.
2. Shifting of location of small islands.
3. Deposition of salts on coastal lands.
4. Destruction of marine ecological resources mainly corals and fishes.

5. Scarcity of drinking water due to contamination by saline water.
6. Damage to ports and harbours,

Preventive measures :-

1. Identification and mapping of areas of tsunamigenic earthquakes.
2. Installation of tsunami meters tracking of under-sea earthquakes and resultant tsunami waves.
3. Provision for prediction and early tsunami warnings system (TWS).
4. Preparedness for timely evacuation of people leaving in the danger coastal zones to safer places.
5. Proper training to govt. officials and local peoples. to educate the coastal inhabitants and fishermen to strictly follows the tsunami guide-lines.
6. Provisions of means of communication of impending danger of tsunami strickes.
7. Community Education
8. Equipments for search and technological rescue operation.
9. Suitable measures for assessment of damage such as aerial surveys.
10. Provision for medical help etc.

Anthropogenic Disasters

Sociological	Technological	Chemical
→ Arsop/ Looting	→ Industrial accident	→ Gas leaks
→ Group clashes	→ Structural Collapse	→ Blasts
→ Stampedes	→ Power Outage	→ Oil spills
→ Bomb Blast		→ Acid rain
→ Terror strikes		→ Radiation nuclear.
→ War		

Transport Related

→ Road accidents
→ Rail accidents
→ Aircraft accidents
→ Ship accidents
→ Space accidents

Technological Disaster

A technological disaster is a catastrophic (a sudden event that cause great destruction) event that is caused by either human error in controlling technology or a malfunction of a technology system.

→ Technological disaster includes;

a) Industrial Accidents

i). Accidents related to processing and storage of hazardous substances.

ii). Accident related to raw material extraction and mining.

(iii). Accidents in manufacturing units mainly dangerous items such as petrochemicals fireworks.

b). Structural failure such as building collapse, dam failure and fire.

c) Power outrage and explosion of hazardous substances (explosive) such as fire cracker accidents.

d) Radiation combination

e) Storage and handelling accidents of bio-logical hazardous agents such as pathogens.

f) Accidents related to chemical, biological, radiological and nuclear substances.

Causes of technological disaster;

The main causes of technological disasters are

1. Improper handelling of hazardous nature of material such as pathogens used in microbiological laboratories for manufacturing drugs and vaccines; Atomic minerals used in nuclear power plants for the generation of electricity, explosives used in the fireworks manufacturing unit etc.
2. lack of prescribed standard safety and protective measures.
3. Carelessness and overlooking safety and prtective measures.
4. Human error while handeling the equipments and machinery due to inadequte training.
5. Fault in Design for machine of infrastructure.

Impacts of technological disaster;

Technological disasters can have adverse effects on individuals, communities and even entire regions. These effects can be both immediate and long-term, impacting various aspects of society, the environment and the economy.

1. Human Casualties;- Technological disasters often result in loss of life and injuries both directly and indirectly explosions, toxic releases, collapese and other incidents can cause immediate fatalities and injuries.

2. Environmental Damage ;- Many technological ha significant environmental impacts, such as contamina of air, water and soil, chemical spills, industrial accidents and nuclear incidents can cause long-lasting damage to ecosystems affecting wildlife and vegetation.

3. Economic Losses ;- The economic consequences of technological disasters can be substantial. Direct cost include property damage, clean-up expenses and healthcare costs for affected individuals. Indirect costs may arise from business interruption loss of productivity and damage to infrastructure.

4. Social Disruption ; Displacement of residents, disruption of services and psychological distress are common.

5. Health Impacts ; Technological disasters can have significant effect on public health. Exposure to hazardous substances can lead to acute and chronic health problems, including respiratory issues, cancer and neurological, disorders, depression.

6. Public Perception and Trust ; Incidents such as industrial accidents or failures in critical infrastructure may lead to doubt about the reliability of technology and the ability of authorities to prevent future disasters.

Bhopal Gas Tragedy - 1984 — 3rd Dec 1984

→ The Bhopal gas tragedy of 3rd Dec 1984 is a burning example ofne of the deadliest disasters caused by human negligence in the maintenance of deadly gases such as MIC gas (Methyle iso-cynate).

→ The leakage of MIC gas from the union carbide factory at Bhopal on the wintry night of December 1984 caused the single biggest air pollution tragedy which, according to official sources claimed 2500 human lives in the early hours of 3rd Dec 1984, whereas non-governmental source put the figure be around 5000.

→ Methyl iso-cynate gas is produced at Bhopal based union carbide factory of the USA to manufacture pesticides.

→ The produced MIC gas is stored in underground containers. The poisonous MIC gas leaked from these containers and the leakage continued for 40 min. The poisonous gas was quickly spread in nearby densely populated localities of old Bhopal under the impact of morning breeze.

→ The poisonous gas also polluted drinking water, soils, tank and pond water and adversely affected foetus, newly born babies, pregnant woman, children young and old people alike.

Heat Waves

Heat Waves are generally defined as pro-longed period of extreme heat conditions which cause serious health hazards and fatalities to humans and severe damages to crop and vegetation.

According to world meteorological organization (WMO) "Heat wave occurs when daily maximum temperature of more than 5 consecutive days exceeds the average maximum temp by 5°C."

Effect of Heat Waves;

The adverse effects of heat Waves include the following;

1. Health issues and fatalities (Death of humans):-

Prolonged period of extreme hot condition leads to human death by sunstrokes and exhaustion, hyperthermia, dehydration and other health-related diseases.

2. Psychological and sociological effects;-

Pro longed extreme hot condition leads to human deaths by sunstrokes and exhaustion, hyperthermia dehydration and other heat-related desiese

   i). Mental stress, Physical stress
   ii). Sleeplessness and irritation
   iii). Struggle for getting water for various uses.

3. Economic effects;-

- Crop damages.
- Destruction of pastures and adverse effect on dairy sector.

4. Power outrages :-

Increase consumption of electricity results in frequent power failure and destruction of substations and power generation centers.

5. Wildfires : -

Intense heat and dry environment cause forest fires and bush fire during prolonged severe heat waves resulting in loss of forest wealth, grasses meant for lifestock, biodiversity etc.

Mitigation of heat waves ;

1. Issue of heat wave alert.
2. Establishment of heat related health centers.
3. Stay indoor as much as possible to escape from heat exposure.
4. Eat healthy light and fresh food, avoid fast food and food kept in the refrigerators,
5. Take sufficient liquid as much possible.
6. Drink water at regular interval of very short duration to avoid dehydration.
7. Do not consume alcoholic beverages as they lead to dehydration.
8. Wear loose fitting white dresses mainly of cotton fabrics.
9. Avoid strenuous and hardwork.
10. Do not work in the open for long if possible take shelter under shade (of trees or bushes) at regular interval and drink water.
11. Take immediate medical help if any symptoms of sun-burns, muscle cramps, fatigue, fever, headache, weakness etc appear. if needed heat patients should be hospitalized etc.

Cold Wave

A cold wave may be defined as the situation of persistence of extreme cold condition with extremely low temperature much below average normal temperature for a few days to a few weeks in relatively larger geographical area.

According to united states weather services," A cold wave is a rapid fall in temperature within 24 hours period."

Impact of cold water;

1. Cold water conditions results in deaths for people not protected properly with sufficient winter clothing or living on pavements.
2. Animal without proper shelter and care die if the cold conditions persist for long periods.
3. In many countries, where temperatures go much below freezing point water supply and sewerage systems may get damaged due to freezing of water.
4. With heavy snow fall, transport systems may come to a halt.
5. Power requirements will be very high for heating homes and offices.
6. Crops get affected due to extreme cold weather leading to shortage of food. Farmers are affected due to poor crop yields.

Mitigation of Cold Waves;

1. Issue of cold wave alert etc.
2. Establishment of night shelter (rain baserars) for homeless, poor workers, rikshaw pullers, beggers etc. to spend nights and escape from exposure to cold condition.
3. Stay indoor as much as possible to escape from cold wheather exposure
4. Arrangement of wood fires at different locations for poor, homeless and other needy persons.
5. Take sufficient warm liquid and food as much as possible,
6. Wear heavy woollen clothing.

Thunderstrooms

Thunderstrooms a violent short-lived weather disturbance that is almost always associated with lightening, thunder, dense clouds, heavy rain or hail, and strong gusty winds.

Thunderstrooms arise when layers of warm, moist air rise in a large, swift updraft to cooler regions of the atmosphere.

Thunderstroom is an intense local strom associated with large, dense cumulonimbus cloude in which there are very strong updraft of air.

Stages of thunderstroom development :-

Thunderstrooms pass through three-stage life-cycle as follows;-

1. Cumulus stage, the first stage of the life cycle of a thunderstorm is also called youth stage, when ground surface is intensely heated, the moist air coming in contact with heated ground surface is also heated expands and rises upward.

2. Mature stage. is the second stage of thunderstorm development characterized by both upward/updraft and downward/downdraft movement of air and occurrence of torrential rainfall from thich cumulonimbus clouds maximum cloud thundering and lightning etc.

3. Dissipating stage is the senile stage of thunderstorms. This final stage is characterized by downward movement of winds laterally spread over the ground surface and stop vertical movement (updraft) of winds.

Hailstorms

When condensation occurs below freezing point, ice particles are formed which range from the size of a pea to a large ball. Hail is not associated with every thunderstrom.

→ Hails fall down on the ground surface when the rising convection currents become weak and feeble.

→ Hails are of three types, namely

1. Soft Hail; also known as graupel, is less than 5 mm in diameter and is crushed and broken when hits the ground.
2. Small Hail is mixed with rain and remains intact when it hits the ground surface.
3. Destructive Hail also called as severe hail, is very large in size and weights from few grams to several kg in weight. Such destructive hails cause maximum destruction. The sudden fall of hails inflicts greate damages to human health and wealth, birds and animals and standing agricultural crop.

Lightning

- Electrical discharge centers are developed in a mature thunderstrom. The centres of positive and negative electrical charges develop in the upper and lower portions of the clouds respectively with discharge values ranging between 20 to 30 coulombs.
- Lightning is produced when the electrical potential gradient between the electrical positive and negative charges become very steep.
- According to another view lightning is produced due to splitting of large water drops. Each water drop has positive and negative electrical charges which remain in neutral state when they are evenly balanced. This balance is disturbed due to splitting of these drops resulting into difference in positive and negative charges.

Thundering

Sound is produced due to sudden and rapid expansion of air columns caused by intense heat (10,000) resulting from lightning strokes. The deafening noise produced by vibrating pressure wave due to rapid expansion of air column as mentioned above is called cloud thunder.

Impact of Thunderstorm;

1. Human casualties mainly through cloud to ground lightning.
2. Death of wildlife through cloud bursts, hails and lightning.
3. Damage to properties including house roofs of glasses automobiles parked or moving in the open.
4. Damage to aircrafts either on the ground or flying through clouds.

5. Damage to crops mainly corn, soybeans, wheat, pulses, oilseeds, potato, onions etc.
6. Wildfires caused by cloud to ground lightning thus destruction of forest and bushes.

Preventive measures during thunderstorm;

1. Not go to open areas if sky turns olive gray surrounding air begins to whistle.
2. If thunderstrooms occur one should immediately take shelter in nearest enclosed building.
3. Must not touch any thing which is plugged in such as electricity swith boards, radio and television sets, rather remove plugs from all electrical appliances and switch off them.
4. Keep emergency first-aids kits in ready position to provide immediate relief to the survivors having burn injuries.
5. Rush the survivors with burn injuries to other organs of the body to the nearest hospital for treatment.
6. Avoid to have glass roofs for homes to save them from hailstorms.

Avalanches

→ Avalanches can be defined as a mass of material moving rapidly down a slope.

→ An avalanche is typically triggered when material on a slope breaks loose from its surroundings and this material then quickly collects and carries additional material down the slope.

→ Avalanches are masses of snow, ice and rocks that fall rapidly down a mountainside.

Types of avalanches;

1. Rock Avalanches:- Which consist of large segments of shattered rock.
2. Ice Avalanches :- Which typically occur in the vicinity of a glacier.
3. Debris Avalanches:- Which contain a variety of unconsolidated materials, such as loose stones and soil.

Biological Disasters

→ Biological disasters are scenarious involving disease, disability or death on a large scale among humans, animals and plants due to toxins or disease caused by live organisms or their products.

→ Such disasters may be natural in the form of epidemics or pandemics of existing, emerging or reemerging diseases and man-made by the international use of disease causing agents in biological warfare operations or incidents of bioterrorism.

→ Biological disaster is defined as, "the devastating effect caused by an enormous spread of a certain kind of living organism that may spread a disease viruses or infestation of plant, animal or insect life on an epidemic or panademic level".

1. Epidemic; It is a disease that affects a large number of people within a community, population or region.
2. Pandemic; It is an epidemic thats spread over multiple countries or continents.
3. Endemic; It is something that belongs to a particular people or country.

4. Outbreak : It is something greater than anticipated increase in the number of epidemic cases. It can also be a single case in a new area. If it's not quickly controlled, an outbreak can become an epidemic.

During Biological Disaster;

1. On hearing the report of a biological disaster, stay indoors and keep calm.
2. Follow newspapers, T.V., radio for regular updates on disaster.
3. Shut all windows and doors and turn off air conditioners.
4. Use a face/gas mask, which can provide an excellent respiratory protection.
5. Reach for medical help, if required.
6. Use purified water or boil drinking water and keep it covered.
7. Store food, fruits, and vegetables under cover to last 5-6 days.
8. Follow hygiene measures such as trimming of finger-nails regularly and washing hands with soap and water before eating/drinking as well as after defecation.
9. Report any case of sickness in the family/neighbourhood to health authorities.
10. Health authorities in destruction of infected stocks of food, crops, livestock etc. Keep our premises clean. Follow proper waste disposal and prevent access to rodents.
11. Use mosquito nets/repellents at night.

UNIT-3 Disaster Management Cycle

Disaster management cycle consists of various steps of policy and administrative decision and operational activities which is taken in planning for and responding to various types of disasters.

Disaster management cycle consists of three different phases and they ar following :-

1. Pre-Disaster Stage
   - Mitigation
   - Preparedness
2. During Disaster Stage
   - Response
3. Past Disaster Stage
   - Recovery

Mitigation ;

- Hazard Mapping
- Vulnerability Analysis
- Mitigation Measures
- Development Control
- Economic Diversification

Preparedness ;

- Disaster management plans
- Early warning systems
- Evacuation strategies shelters
- Inventory warehousing
- Communication
- Public Awareness
- Education and training
- Mock Drills

Recovery;

- Reconstruction of houses
- Water supply
- Infrastructure Agriculture
- Commercial
- Establishment
- Rehabilitation
- Livelihood
- Continued medical help

Response;

- Rescue Operations
- Providing Shelter
- Providing Food and Water
- Medical Help
- Information to all
- Identification of the dead
- Preserving bodies
- Special needs

Components of Disaster Management

Disaster management involves a comprehensive approach to mitigate, prepare for respond to and recover from diseasters. It consists of several interconnected components that work together to reduce the impact of disasters are enhance community resilence. The key components of disaster management are following

1. Risk Assessment
2. Mitigation
3. Preparedness
4. Response
5. Recovery
6. Coordination and communication
7. Resource Management
8. Community Engagement
9. Evaluation and Learning
10. International Cooperation.

Risk Assessment ; Risk assessment involves the assessment or identification, analysis and evaluation of hazards, vulnerabilities and potential impacts on communities and infrastructure. It helps determine the level of risk and informs decision making for effective disaster management strategies.

Mitigation; Mitigations aims to reduce the likelihood and severity of potential disasters. It includes measure such as land-use planning, structural and non-structural measures and environmental management to minimize vulnerabilities and enhance resilence.

Preparedness ; Preparedness activities focus on building the capacity to respond effectively to disasters. This includes developing emergency response plans, conducting training and drills estabilishing early warning systems and enhancing public awareness and education about risks and protective measures.

Response ; The response phase involves the immediate actions taken to save lives, protect property, and meet basic needs during and immediately after a disaster. It includes activities such as search and rescue, emergency medical services, evacuation providing shelter and essential services and coordinating multi-agency response efforts.

Recovery ; Recovery involves the restoration and rebuilding of affected communities and infrastructure after a disaster. It includes activities such as damage assesment, debris removal, infrastructure repair and reconstruction, economic recovery, social and psychological support and long-term community development planning.

Coordination and Communication; Effective coordination and communication are essential throughout all phases of disaster management. This involves establishing coordination mechanisms, effective activating emergency operations centres, coordinating with various stakeholders and agencies and ensuring timely accurate flow of time information to support decision-making and response efforts.

Resource Management; Resource management involves the identification, acquisition, allocation and tracking of resources required for disaster management. This includes personnel, equipment, supplies facilities and financial resources. Effective resources management ensures that the necessary resources are available and utilized effectively during emergencies.

Community Engagement; Engaging and involving the affected communities in disaster management is crucial for effective response and recovery. It includes community participation in planning, decision making and implementation of disaster management strategies. Engagement communities promotes ownership, increases resilience, and fosters a sense of empowerment and self-reliance.

Evaluation and learning; Evaluation and learning are important components of disaster management to assess the effective response effectiveness of strategies, identify gaps and areas for improvement and capture lessons learned. It involves conducting post-disaster evaluations analyzing feedback from stakeholders and integrating finding into future planning and preparedness efforts.

Pred.

International Cooperation :- Give the transboundary nature of some disasters and the potential need for external assistance international cooperation is an important component of disaster management. It involves collaboration information sharing, resource mobilizations and technical assistance among countries and international organizations to support disaster response and recovery efforts.

Pre-Disaster Stage

Pre-disaster stage of disaster reduction and management aims at informing the people of the area to be affected by a hazard and disaster well in advance, to make the community prepared and mently ready to face any sort of eventuality through various measures; to minimize the probable adverse effects and to prevent the occurrence of a hazard.

→ Thus the pre disaster stage includes the following three major steps :

1. Disater Preparedness :
2. Disaster Mitigation
3. Disaster Prevention

Mitigation Phase

→ Mitigation refers to all the measures taken to reduce the risk from disasters. This can be done through many actions that are aimed at increasing the capacity and resilience of the individuals and community.

→ The objective of mitigation are to ;-

1. Reduce the risk due to natural & man-made disasters
2. Prepare and enforce structural mitigation measures like building regulations and their implementation.
3. Reduce risk by exercising control over developmen
4. Help vulnerable population putting in place measures for crop planning, urban planning, and land uses regulation.

→ The various measure step taken under mitigation phase are following

1. Hazard Maping
2. Vulnerability Analysis
3. Mitigation Measures for buildings.
4. Control over development and economic activities

Hazard Mapping ;

→ A hazard map shows the hazard likely in a region.

→ A hazard map is made to identify the regions affected by a single hazard.

→ A hazard map has basically two objectives;

(i) To make the people of the region aware of the hazards likely in the region.

(ii) To help disaster managers and other stake holders to plan and be prepared for the disaster as and when it occurs.

→ To prepare a hazard map, data is required about the hazards that have happened in the region in the past.

→ This is obtained from essentially two sources;-

a) Recorded History;

For the last many decides records of hazards that have occured in different regions of the world are available. These are being compiled in many countries for the purpose of disaster mitigation. Such records give an indication of the likely hazards in a country or region.

b) Information gathered from the community;

Where records are not available or insufficient, it is necessary to talk to the people living in the region who may remember the hazards they themselves has faced or have heard about from their elders.

2 Vulnerability Analysis;-

The vulnerability thus gives as a picture of the risk that people or regions maybe subjected to and to focus on those aspects wher vulnerability increases the severity of a disaster.

3. Mitigation measures for buildings structural;
This means ensuring that houses, offices and other commercial buildings can withstand the likely disaster.

4. Control over development and economic activities;
The government should have policies and practies in place for land use for various purpose agricultural crop patterns etc.

Preparedness Phase

→ Preparedness is the second phase of the disaster management cycle.
→ This basically indicates the measures required for being equipped to face disasters that are likely to occur in the region.
→ The objective of preparedness are to;
i). Ensure Public awareness and preparedness for disasters.
ii). Prepare and be ready to implement a disaster management plan.
iii). Ensure stardard procedures for evacuation and immediate relief.
iv). Prepare sheltering plan and ensure physical availability of shelters.
v). Have plans for warehousing of relief materials and logistics of operation.
vi). Ensure availability of healthcare services by identifying teams and availability of medicines and other essential materials.

→ The major steps in this phase are following;-

1. Disaster management plan (DMP)
2. Early warning systems
3. Evacuation plans
4. Shelters and sheltering plans
5. Inventory of resources
6. Warehousing of relief materials
7. Communication
8. Education and training of personnel.
9. Public awareness programmes.

1. Disaster Management Plan

The first step in disaster preparedness is the making of a disaster management plan that only represents what the local government and communities are capable of doing to cope with a disaster

2. Early warning system

Whenever possible people must be made aware of an impending disaster in advance. This will given them time to prepare themselves for leaving their homes for safer areas. Many natural phenomena are predictable. It is possible to issue early warnings to the people likely to be affected by the event. Such warnings helps to reduce loss of life and property.

3. Evacuation Plan

In many instances like a cyclone (which is quite predictable now-a-days) a major task before the disaster strikes will be evacuate people from the areas that the cyclone will affect.

4. Shelters and sheltering Plans ;-

A basic need of displaced persons in a place to live in and be safe from nature's fury. A disaster management plan would have identified dedicated shelters or buildings like schools that can be used to accommodate people displaced from their homes, such temporary shelters.

5. Inventory of resources ;-

An inventory must be made of all the resources available for disaster management. The inventory includes material resources, equipment, trained personnel etc.

6. Public Awareness Programmes ;-

An informed community has greater awareness about hazards and risks and ability and confidence to cope with disasters.

Response Phase

→ Response is the stage immediately after a disaster, when the occurrence of the disaster is known.

→ This is a critical phase and many agencies are involved in the operations.

→ The objectives of the response phase are to;

1. Provide immediate relief to reduce the suffering of the affected people.
2. Conduct search operations and rescue those stranded.
3. Provide food, water and accommodation in temporary shelters to displaced people.

4. Provide medical services as many be needed to people injured.

5. Take measures to prevent unhygienic condition that can cause diseases and their spread.

→ While the response steps may very according to the the following steps are common to many of them.

1. Search and resuce
2. Medical Care
3. Humanitarian Relief
4. Coordination

1. **Search and rescue ;**

Search and rescue or SAR, as it is called, is a technical activity normally rendered by a groud of specially trained personnel, who rescue and attend to the casualities under adverse conditions, where life is under threat.

→ It is organized in close coopration with the community with a team orientation.

→ It is a procedure carried out immediately after a disaster to look for survivors and dead ones, through prior training, education, mock exercises and awareness among the local population, maybe lives can be saved and disabilities or injuries can be minimzed.

2. **Medical Care ;**

An immediate requirement when rescue efforts are going on is medical help. Some people may have minor injuries that need first aid immediately. Some other may have serious injuries requiring hospitalisation.

On-field care and ambulance services must be available. Many others may need heavy medication and surgical procedures to save their lives.

3. Humanitarian Relief;-

With thousands of people displaced from their homes and having lost their resources or unable to use them, humanitarian aid is a first priority. Shelter food and water will be primary needs of individuals.

4. Coordination ;-

During the response phase in particular with multiple agencies offering their help and present at many sites, coordination of efforts is a key factor. Setting up of a control room and identifying the person in command, as per the SOPif available, is a first step in coordination.

For coordination of the response of the response efforts the following points are important;-

a) Unified Command :- A person most suitably a government official should be identified as the person commanding the whole operation.

b) Control Room :- The control room should be operating 24 hours of the day with a good communication set-up to communicate with people at different location.

c) Information To Media :- Media briefing should be done daily so that correct information goes to the world at large, rumours can cause immense miscommunication and confusion, resulting in hardship and suffering to people.

Recovery Phase

The recovery phase starts after the immediate threat to human life. The immediate goal of the recovery phase is to bring the affected area back to normaly as quickly as possible.

→ The recovery process can be very long and may take years to accomplish.

→ The main objectives of recovery phase are;

1. To take care of the displaced person till they are able to return to their homes are made livable.
2. To assess the damage to infra structure and houses for the displaced persons.
3. To undertake economic rehabilitation of people who have lost their livelihood.
4. To ensure that essential services like water, sanitation and power supply are available to people.

→ Recovery Phase includes various major steps;

A. Assessment of Damage
B. Reconstruction
C. Economic Rehabilitation.

Assessment of damage;

→ The first task on the people-in-charge of disaster management is to assess the damage to propery. This may include.

a) Number of collapsed houses, damaged houses and public buildings
b) Damage to road & rail network.
c) Damage to water supply systems and sanitation syetems.
d) Power supply systems and lines and equipment damaged.
e) Damage to communication network.

f). Environmental damage, loss of animal, trees damage to water bodies.

→ Starting operating procedure will have detailed instruction on the assessment of damage and the person responsible for reconstruction. The cost will include;

i) Rebuilding collapsed houses damaged houses and public buildings

ii) Compensation to people for the damages.

iii) Retro-fitting of partially damaged buildings.

iv) Cost of removing debris reconstruction of roads, railways, powers and communication network, re-laying of water and sanitation systems.

v) Cost of supporting people with food and shelter till they are able to move into their own houses.

vi) Cost of economic rehabilitation.

vii) Cost of restoring the damage to the environment.

→ All the cost should be worked out on current prices, with escalation for time lapse due to shortage of funding and delays in implementation of reconstruction plans.

Re-construction;

→ The reconstruction of public utilities and services take priority as they have an impact of a large number of people

→ Water supply system, sanitation system and power supply system/lines must be set right so that people have these services at the earliest.

→ Attention will have to go to communication and transportation network which are again vital for many services. With international help, both in terms of money and experties, these can be set right fast.

→ Reconstruction work may go on for years. People will have to be compensated suitably during this period by way of monitory assistance.

Economic Rehabilitation;

→ A disaster may bring to halt many economic activities like manufacturing trade and agriculture on which many people depend for their livelihood. As the restarting of many economic activities may take a long time, people need to be provided alternative source of income.

→ creating a data base of people with their skill sets may help to assign jobs suitable to them for their economic rehabilitation. They can be employed in the reconstruction activities to give them a source of income.

→ Many action can be taken to reduce the suffering of people due to loss of livelihood;-

1. Provide economic support to people for minimum standard of living.
2. Give easy loans and aid to take-up some economic activity.
3. Provide employment in the reconstruction activities.
4. Provide support and technical facilities to industry to restart operations and so on.
5. Adopting alternative crop pattern and practices to reduce losses

UNIT-4 Disaster Profile of India

Disaster Profile;

The geophysical conditions and geographical location and extent make india more vulnerable to natural disasters such as earth-quakes, landslides, floods, droughts, cloud bursts etc.

The four major physiographic regions of india viz the himalayas, north Indianplains, peninsular India and coastal plains are intimately related to particular types of natural disasters as follows;

1. The Himalayan Region
   - → Earthquakes
   - → Landslides
   - → Snow storms and avalanches
   - → Cloudbursts and lightning
   - → Flash floods.
2. The greate northern plains
   - → Heavy rains
   - → Flash floods
   - → floods
   - → Droughts, heat waves and dust storms
   - → Thunderstorms and lightning
   - → Earthquakes
   - → Cold waves
3. The Plateau Region (Including Deserts)
   - → Earthquakes
   - → Landslides
   - → Floods
   - → Droughts
4. The coastal plain region
   - → Cyclonic storms → Heavy rains, cloud brusts
   - → Tidal and storms surges → Tsunamis
   - → Earthquakes

The following are the salient features of India's vulnerability to different natural disasters;

→ Out of total 36 states and union territories in India 27 of them are vulnerable to different type of natural disasters.

→ Slightly more than 59 percent of the total geographical area of landmass is vulnerable to earthquake disaster as it falls under the seismic Zones III to V.

→ About 40 million hectare landmass accounting for 12 percent of land areas is flood-prone and is vulnerable to frequent floods almost every year.

→ About 68 percent of arable land areas is vulnerable to drought disaster.

→ Sub-Himalayan region and western ghats are vulnerable to landslides disaster.

→ Coastal states (both eastern and western) are vulnerable to cyclonic storms and tsunami disasters.

→ 199 districts of the country are vulnerable to multi-natural disasters.

→ Out of 199 districts, 125 in 12 states of the country are most vulnerable to multiple natural disasters.

Paradigm shift in disaster management in India

There is a major paradigm shift in the methods and approaches to disaster management in India after the catastrophe of Bhuj earthquake 2001 and Indian Ocean tsunami in 2004.

1. The pre-2004 disaster management was based on relief-centric response, meaning there by only post-disaster response comprising rescue and relief works rehabilitation and reconstruction was at the heart of disaster management in India.

2. The post-2004 tsunami scenario disaster management approach become proactive prevention, mitigation and preparedness centric for conserving developmental gains and to minimise loss of life, livelihood and property.

Thus the present method and approach to disaster management is more comprehensive, purposeful & welfare-oriented as it comprises all the activities and programmes of pre-disaster stage and post-disaster stage as follows;-

Pre-Disaster Stage
- Disaster prevention
- Disaster mitigation
- Disaster preparedness

Post Disaster Stage
- Rescue and relief work
- Rehabilitation
- Reconstruction and recovery

Disaster Management Act 2005;

The disaster management act is a legislation enacted by the government of India to provide a legal framework for effective disaster management in the country

Disaster management act of 2005 is an act passed by the government of India to provide a legal framework for effective disaster management for the efficient management of disasters and other matters connected to it and the act received the assent of the president of India on 23rd December 2005.

The act empowers the central government, state governments and district authorities to take proactive measure for prevention, mitigation, preparedness, response and recovery from disasters.

Objective of Disaster management act 2005;

1. This act provides for the effective management of disaster and for matters connected therewith or incidental there to.
2. It provide institutional mechanisms for drawing up and monitoring the implementation of the disaster management.
3. The act also ensures measures by the various wings of the government for prevention and mitigation of disasters and prompt response to any disaster situation.

Institutional Framework under DM act, 2005

The following are institutional and organizational structures under disaster management act 2005;-

1. National disaster management authority (NDMA)
   → under the chairmanship of prime minister
2. State Disaster Management Authority (SDMA)
   → Headed by the chief minister of concerned state.
3. District Disaster Management Authority (DDMA)
   → Under the chairmanship of district magistrate or collector of the district of the state.
4. National Executive committee (NEC)
   → Under the chairmanship of Union home secretary, Govt. of India.

5. National Disaster Response Force (NDRF)
→ Under direct control of NDMA.
6. National Institute of Disaster Management (NIDM)

National Disaster Management Authority

→ NDMA is the apex body that is responsible to lay down policies, plans and guidelines for disaster management to ensure effective and timely response to disasters at the national level of and in India.

→ It was established under the disaster management act 2005. The prime minister of India serves as the chairperson of NDMA. The authority formulates policies, plans, and guidelines for disaster management across the country.

→ It coordinates with various central ministries state governments and other stakeholders to ensure a unified and effective response to disasters.

→ NDMA also oversees the functioning of the national disaster response force (NDRF) and provides strategic direction during major disaster events.

Responsibilities of NDMA;

The functions of NDMA are followings;-

1. Lay down policies with reference to disaster management across the country.
2. Approve plans prepared by the ministries or departments of the government of India in accordance with the national plan for disaster management.

3. Lay down guidelines for state level disaster management authorities for drawing up state level plan.
4. Recommend provision of funds for the purpose of mitigation.
5. Lay down broad policies and guidelines for the functioning of the national institute of disaster management.
6. The general superintendence, direction and control of the national disaster relief force are vested in and will be exercised by the NDMA.
7. Provide such support to other countries affected by major disasters as may be determined by the central government.

National Executive Committee (NEC)

The national executive committee is chaired by the Home Secretary and comprises secretaries in the ministries and departments of;

1. Agriculture
2. Atomic energy
3. Defence
4. Water supply
5. Environment and Forests
6. Finance
7. Urban Development
8. Chief of the integrated defence staff of the chiefs of the staff committee.
9. Health
10. Power
11. Rular Development
12. Science & Technology
13. Space
14. Telecommunications
15. Water resouried development.

→ Secretaries to the following ministries will be spacial invited.

i) External Affairs
ii) Earth sciences
iii) Human resource development
iv) Mines
v) shipping
vi) Road Transport and highways.

→ Secretary of NDMA will also invited.

Responsibilities of NEC

The national executive committee is the executive arm of the NDMA. Its main responsibilities are following;

1. To assist the NDMA in the discharge of its functions.
2. To ensure compliance of instructions issued by the central government.
3. To coordinate the response to any impending disaster situation or a disaster.
4. To prepare a national plan for disaster management as per the national policies on disaster management.
5. To monitor the implementation of the guidelines issued by the NDMA.
6. To perform any other functions as prescribed by the central government or NDMA.

National Disaster Response Force (NDRF)

→ The national disaster response force is a specialized force dedicated to disaster responses and rescue operations.

→ It operates under the national disaster management authority.

→ The NDRF is comprised of highly trained personnel and equipped with modern equipment to respond to various types of disasters, including earthquakes, cyclones, floods and others emergencies.

→ NDRF teams are strategically located across the country to ensure a rapid response during disasters. They work in coordination with state governments and other agencies to provide timely assistance in search and rescue, medical support and evacuation of affected people.

Role of NDRF ;

1. To provide national level assistance to the states UTs/ in disaster.
2. To coordinate with other national & international agencies during disaster.
3. To undertake rescue and relief operations in disaster
4. To provide medical assistance
5. To provide logistic support to the states/UTs during a disaster.
6. To conduct search and rescue operations
7. National disaster response force also undertakes capacity building of state/UT force.

Non- Government Organisations (NGOs)

→ NGO can be defined as "A non-governmental organization (NGO) is any non-profit voluntary citizens' group which is organized on a local, national or international level.

— Task oriented and driven by people with a common interest NGOs perform a variety of services and humanitarian functions. There are national level NGOs acting as donor and advocacy organizations state level NGOs involved in mobilizing communities through various campaigns as well as action research and local NGOs working directly with communities.

→ NGOs play an important role in disaster management by providing additional resources expertise and support to affected communities.

→ The often work alongside government agencies and provide assistance in areas such as humanitarian aid, shelter, food distribution and psychosocial support.

Role of NGOs in various Phase of Disaster Management

— During Mitigation Phase;

1. Advocating at the appropriate forums including legislative and policy levels for disaster mitigation to be institutionalised in policy, legislative and institutional frameworks.
2. Disaster mitigation awareness and capacity-building activities promoting inclusive disaster management approaches.

3. Constructing shelters public buildings and other infrastructure safe from disasters
4. Improving water and sanitation system.

→ During response phase

1. NGOs work closely with communities and can help mobilise them for evacuation and taking precautions in an emerging situation.
2. Search and rescue operations are highly specialised jobs and NGOs can help local authority in registration, data collection and documentation of the people evacuated.
3. NGOs can also help for deploying team for immediate, sector-specific and periodic in-depth assessments.

→ During recovery phase

1. Identification of beneficiaries and their specific needs.
2. Monitoring health care efforts.
3. Identifying special needs.
4. Collecting data about progress of recovery.
5. Just and equitable distribution of compensation and material relief.

UNIT-5 Early Warning System

Early Warning System

Early warning system in disaster management are crucial tools used to detect and forecast potential hazards or emergencies and provide timely information and alerts to at risk population. This system aim to minimize the loss of life and property damage by giving people the opportunity to take appropriate action in advance.

→ Early warning system are designed to monitor various hazards such as natural disasters (eg. hurricanes, earthquakes, floods), technological disaster (eg. industrial explosions, chemical spills) and human induced emergencies (eg. terrorist attack, pandemics)

→ The primary purpose is to provide advance notice to potentially affected communities, government and relevent agencies.

Components of early warning system;

Early warning systems typically consist of several components;

1. Hazard monitoring and Detection

This involves the continuous monitoring of data from various sources such as meteorological stations, seismological networks and remote sensing technologies to detect the occurance or development of potential hazards.

2. Data Analysis and Forecasting

Collected data is analyzed to access the severity and trajectory of the hard, enbling forecast models to predict its potential impact on the affected area.

3. Communication and dissemination

Once the hazard is identified and forecasted, timely and accurate informatics disseminated through various channels, including radio, television, devices, sirens and community networks. The aim is to reach as many people possible, especially those in high risk areas.

4. Preparedness and response planning

Early warning system also involve developing respone plans including evacuation routes, emergency shelters and resource mobilization strategies. These plans are crucial to ensure that communities are prepared to take a when warning are issued.

5. Monitoring and Evaluation

Continuous monitoring and evaluation of early warning system's perform help identify area for improvement and ensure its effectiveness in future dis-situation.

Advantages of Early warning system;

1. Early warning system save life by alerting people in advance of impending disasters. By providing timely warnings people can evacuate to safer areas or take appropriate actions to protect themselves.
2. Early warning systems contribute to improved disaster preparedness by raising awareness and educating communities about potential risk and appropriate response.
3. Effective early warning system facilitate better coordination among various stake holders involves in disaster response, including government agencies, emergency services, non-governmental organizations and the public.

4. By minimizing the loss of life and property damage, early warning system can help reduce the economic impact of disaster on affected communities and regions.

Dis-advanges of early warning system;

1. Early warning system may sometimes issue false alarms, either due to technical error, inaccurate data interpretation or uncertainties in forecasting.
2. Early warning system may not cover all geographical areas or types of hazards equally. Rular or remote region for example may have limited access to warning infrastructure such as communication network or monitoring devices.
3. Not all members of a community may have access to or be reached by early warning messages, particularly vulnerable populations such as the elderly, disabled or those with limited access to technology or information.
4. Early warning system heavily in technology, including communication networks, sensors and forecasting models. Disruptions to these technologies whether due to natural disasters, technical failure or cyber-attack can compromise the effectiveness of the warning system.

Remote Sensing

→ Remote sensing means sensing something from a distance or a remote location.

→ Remote sensing now is a technology based on satellites orbiting the earth which means sensing, or collecting information about something from a distance.

→ Remote sensing is not such a uncommon phenomenon as human vision itself is an example of remote sensing. Photography is another example.

→ The terms remote sensing includes a wide range of processes like photography, aerial photography and obtaining information using a variety of sensors on satelite platform.

→ Any type of imagery, taken from aircrafts or satellites using many type of scanning system, comes under the category of remote sensing. Photographs, digital or CCD images and images using thermal or other scanning system are used. The images can be used for qualitative assessment or for quantitative evaluation.

Role of remote sensing in disaster management;

In disaster management, remote sensing as a technique and data obtained from it has been found to be very useful;

1. Aerial photography is used to survey an area to determine the extent of floods, forest fires etc, and assess damage to infrastructure and crops.
2. Remote sensing is perhaps the only way to monitor volcanic eruptions.
3. Remote sensing can be used to find the damage due to earthquake in remote areas. It is also useful for monitoring landslides, avalanches etc.
4. Monitoring by aerial surveys is done to get updates about to extent of damage or a threatening situation.
5. Urban planning and land use data are useful in disaster mitigation.

Global Positioning System (GPS)

The global positioning system is a system of sattelites and receiving devices that allow people and devices to determine there precise location on the earth.

Global positioning system also called NAVSTAR (NAVigation System Timing And Ranging) is a space based navigation system that provide location and time information in all weather conditions, anywhere on or near Earth.

Functional segment of GPS;

GPS consist of three segments

1. Space segment - Satellites orbiting the earth.
2. Control segment - Station positioned on the earth's equator to control the satellites.
3. User segment - Anybody that receives and uses the GPS signals.

Role of GPS in Disaster management;

→ Global Positioning system technology plays a crucial role in disaster management by providing accurate positioning, navigation and timing capabilities that aid in preparedness response and recovery efforts.

1. GPS technology is used to map hazard-prone areas assess vulnerability and identify potential disaster risks such as flood zone, earthquakes fault lines and wild fire prone areas.
2. Global Positioning system enables responders to accurately locate and navigate to incident locations standard individuals and disaster survivors.
3. GPS Tracking system are used to monitor the movement and location of emergency vehicles, supplies and personnel in real-time.

4. GPS technology is used to access and map the extent of damage caused by natural disaster, such as hurricanes earthquakes and wildfires.

Geographical Information System (GIS)

→ A geographical information system is a computer based tool for mapping and analysing things that exist and events that happens on earth.

→ GIS enables the user to store, retrieve and manipulate such data and provide output in many forms for managers to take decision on different planning.

→ Geographical information system is a management information system developed to store, manipulate, analyze and output georeferenced data in the form of maps, tables and other forms for the purpose of planning and management of natural resources transportation, environment, infra-structure socio economic development projects and other administrative records.

Components of GIS :-

A working GIS integrates five key components :-

1. Hardware

This refers to the computer and associated equipments needed to operate the software, collect or print data and maps.

2. Software

The application and the tools that allows users to collect, analyze and visualize geographic information are the sofware.

3. Users :

Users are the people from whom the GIS is developed. User look for different kind of information depending upon the purpose and application. Information and analysis and output is provided in the format the user want them.

4. Methods :

They are well designed plans and application specific business rules describing how technology applied. This include the following.

- → Guidelines
- → Specifications
- → Standards
- → Procedures

5. Data :

One of the most important component of GIS is the data is absolutely essential that data be accurate. The following are different data types ;

1. Vector Data

The three basic symbol for vector data are points, lines and polygons.

2. Raster Data

Raster data is represented as mixture of pixels arranged into rows and columns as grids. In an image, each pixel will have a red, green and blue value, but the value of a pixel could also represent average rainfall, temperature, elevation, CO_2 levels etc.

Role of GIC in disaster management :-

→ Preparing disaster incidence records and showing them on maps.
→ Conducting different types of vulnerability studies for specific areas.
→ Planning and designing mitigation measures.
→ Designing disaster preparedness measures.
→ Designing disaster response including arranging for logistics.
→ Planning for recovery measures.
→ Assessment of damage and mitigation monitoring.
→ Planning and location of temporary shelters and designing of relocation programmes.