Disaster management: Floods, Earthquake, Cyclones and Landslides

A **disaster (** Fr. *desastre*=bad star**)** refers to sudden serious disruption of normal functioning of a society, involving large damages to life, property and environment, beyond its ability to cope with its own resources. It can be natural or man-made

A natural disaster is a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. E.g. agricultural diseases & pests, damaging winds, drought and water shortage, earthquakes, emergency diseases (pandemic influenza), extreme heat, floods and flash floods, hail, hurricanes and tropical storms, landslides & debris flow, thunderstorms and lighting, tornadoes, tsunamis, wildfire etc.

Man-made disaster: Human-instigated disasters are the consequence of technological hazards E.g. hazardous materials, power service disruption & blackout, nuclear blast, radiological emergencies, chemical threat and biological weapons, cyber-attacks, war etc.

Some disasters can result from combination of both Natural and Man-made causes. These are called as complex emergencies.

Disaster Management refers to managing disaster response in the country (Table). India has been traditionally vulnerable to the natural disasters on the account of its unique geo-climatic conditions. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; about 8% of the total area is prone to cyclones and 69% of the area is susceptible to drought.

Table: The four phases of disaster management

Mitigation: Preventing future emergencies or minimizing their effects	: Includes any activities that can prevent or reduce the chance of occurrence of an emergency, or reduce the damaging effects of unavoidable emergencies. : Mitigation activities take place before and after emergencies. : This can be done by revised zoning, land use management, etc.
Preparedness: Preparing to handle an emergency	: Includes plans or preparations for disaster and to help response and rescue operations. : Evacuation plans and stocking food and water are both examples of preparedness. : Preparedness activities take place before an emergency occurs.

Response: Responding safely to an emergency	: Includes actions which are to be taken to save lives and prevent further property damage. Response is putting your preparedness plans into action. : Seeking shelter from a tornado or turning off gas valves in an earthquake are both response activities. : Response activities take place during an emergency.
Recovery Recovering from an emergency	: Includes actions need to be taken to return to a normal or an even safer situation following an emergency and one should also consider things which would mitigate the effects of future disasters. : Recovery includes getting financial assistance to help pay for the repairs. : Recovery activities take place after a disaster.

National Disaster Management Authority (**NDMA)** is an agency of the Ministry of Home Affairs and is responsible for framing policies, laying down guidelines and coordinating with the State Disaster Management Authorities (SDMAs) to ensure a holistic and distributed approach to disaster management. NDMA was established through the Disaster Management Act enacted by the Government of India in May 30, 2005. The Prime Minister is the ex-officio chairperson of it.

FLOODS

Floods occur when land that is usually dry is submerged by large amounts of water. Sudden submergence or inundation of land area with water is called as flood. The occurrence of floods can be due to both natural and human causes.

1. **Anthropogenic causes of floods include: Clearing of forests:** Lack of vegetation cover to hold the soil together on slopes causes erosion and deposition in river beds making them shallow, flooding occurs when these rivers overflow. Also bare slopes increase surface runoff and volume of water flowing into the rivers.
2. **Urban development:** The clearing of land for development of residential, commercial and industrial complexes have rapidly increased built-up areas. These concrete pavements and roads prevent infiltration of rainwater into the ground coupled with lack of vegetation cover to intercept the rain water results in increased runoff flowing into the rivers resulting in flooding.
3. **Improper farming and other land use practices:** The combination of absence of forest cover on one hand, and inappropriate farming and land-use practices on the other have aggravated the flood devastation. There are hardly any forests left in the catchment area of the rivers. It is well known fact that the forest areas are characterized by high infiltration capacity.
4. **Enhanced Green house effect:** Various human activities resulting in increased green house effect and causing global warming are leading to various climate changes such as higher rainfall in short duration, melting of more ice etc. All these have lead to increased incidences of floods.

Natural causes of floods:

1. **Excessive rainfall:** Floods occur when rainwater is unable to seep into the ground quickly enough or rivers overflow their banks because river channels cannot contain excess water. It is common in tropical areas.
2. **Storm Surges:** It occurs when strong winds raise the waves in the ocean to exceptionally high levels, causing them to crash into the coast and flood the land. It is common in coastal areas with low-lying relief.
3. **Melting Snow:** Melting of snow in spring releases large amount of water into the rivers, causing them to overflow their banks. It is common in places with cool temperate climate.
4. **Global Atmospheric processes:** Abnormal weather phenomenon such as El Nino (warming of surface ocean waters at Southeastern part of Pacific Ocean).
5. **Earthquakes:** Earthquakes can bring about landslides or trigger tsunamis. When landslides occur, loosened soil, rocks, mud debris etc. may be deposited in rivers causing overflowing of these rivers. Tsunamis triggered by strong undersea earthquakes can flood and devastate coastal settlements.

Impact of floods:

1. **Loss of life**: Floods mostly strike people unprepared, leading to loss of lives in drowning. Along with livestock and other life forms. Impact is higher in flood plain areas which are densly populated,
2. **Damage to infrastructure and property:** Flood cause huge losses to homes, roads, power supply and other infrastructure.
3. **Spread of Diseases:** After flood water recedes, shallow stagnant water may cover areas over a considerable period of times. This may result in outbreak of water borne diseases. Moreover homeless flood victims are housed in temporary shelters which are mostly overcrowded and with poor sanitation conditions which may turn situation worse.
4. **Loss of natural habitat:** Trees, vegetation and other natural habitats may get destroyed leading to loss of biodiversity.

Mitigation of floods

Floods can be mitigated by structural, water control and non-structural measures such as:

Structural methods include building dams, reservoirs, and retarding basins, channel management and embankments.

Water control methods: include increasing forest and vegetation cover, watershed management, flood proofing and catchment modifications. Schemes of drainage and flood protection,

Non-structural methods: flood forecasting, flood warning and emergency preparedness systems, flood insurance, public information and education, and flood relief

Earthquake

An **earthquake** (also known as a quake, tremor or temblor) is the shaking of the surface of the Earth, with sudden release of energy in the form of seismic waves on the surface of the earth. The point inside the crust where the pressure is released is called the focus. The point on the Earth's surface above the focus is called the epicentre. When earthquake occurs beneath the sea it causes tsunami. The study of earthquakes is called as seismology and the instrument used to measure seismic waves is called as seismometer or seismograph. The magnitude of earthquake is measured by richter scale and intensity by mercalli scale(Table).

Table: Effects on earthquake with various magntitudes.

Magnitude	**Description**	**Mercalli intensity**	**Average earthquake effects**
1.0–1.9	Micro	I	Microearthquakes, not felt, or felt rarely.
2.0–2.9	Minor	I to II	Felt slightly by some people. No damage to buildings.
3.0–3.9		III to IV	Often felt by people, but very rarely causes damage.
4.0–4.9	Light	IV to VI	Noticeable shaking of indoor objects and rattling noises. Felt by most people in the affected area. Generally causes none to minimal damage.

5.0–5.9	Moderate	VI to VII	Can cause damage to poorly constructed buildings. None to slight damage to all other buildings. Felt by everyone.
6.0–6.9	Strong	VIII to X	Destructive. Earthquake-resistant structures survive with slight to moderate damage. Poorly designed structures receive moderate to severe damage.
7.0–7.9	Major	X	Causes damage to most buildings, some partially or completely collapse or receive severe damage.
8.0–8.9	Great		Major damage, structures likely to be destroyed. Damage earthquake-resistant buildings. Felt in extremely large regions.
9.0 and greater			At or near total destruction – severe damage or collapse to all buildings. Permanent changes in ground topography.

Souce: U.S. Geological Survey documents

Causes of earthquake: According to the theory of plate tectonics, Earth is composed of many individual plates that move and interact, constantly changing and reshaping Earth's outer layer. Plates do not always move smoothly against each other and sometimes get stuck. This builds up pressure. When this pressure is eventually released, an earthquake tends to occur. Volcanoes and earthquakes both result from the movement of tectonic plates. Volcanoes, tides can also trigger seismicity.Underground nuclear testing and dams can also cause seismic waves.

Effects:

1) Soil Liquefaction:- Due to earthquakes granular material (such as sand) temporarily loses its strength and transforms from a solid to a liquid (Soil liquefaction). This causes rigid structures, like buildings and bridges, to tilt or sink into the liquefied deposits.

2) Landslides and **avalanche** : Earthquakes can produce slope instability leading to landslides and avalanche.

3) Tsunamis: When earthquakes occur under sea it causes tsunami. Most destructive tsunamis are caused by earthquakes of magnitude 7.5 or more.

4) Floods: These are secondary effects of earthquakes, as they may occur if dams are damaged.

5) Fires: Earthquakes can cause fires by damaging electrical power or gas lines.

6) Destabilization: It destabilizes ecological and social structure of nation. Essential services also got disrupted.

7) Loss of life and property: An earthquake may cause injury and loss of life, general property damage and collapse or destabilization of buildings. The aftermath may bring disease, lack of basic necessities, mental consequences such as panic attacks and depression to survivors etc. E.g. Earthquake in 2005 with Epicenter at Muzaffarabad killed 80,000 people and injured around 1,00,000 and 3.5 million people were dislodged.

Management and mitigation methods:

Earthquakes cannot be stopped or predicted accurately but certain management techniques could be followed to minimize its effect:

1) Construction of buildings which can tolerate earthquakes. This can be done by:

a) By keeping weak spots in building to absorb vibrations.

b) To keep pads or floats beneath buildings.

c) Wooden house to be preferred in earthquake prone area.

2) Soil testing should be done so that stability of building is assured.

3) Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes.

4) Preparedness and safe building construction can reduce extent of damage and loss.

5) Establishment of GPS station in the earthquake prone region to assess future crustal movements.

J&K falls in seismic zones IV (high) and V (very high). So, we need to be more aware about precautionary measures against earthquake.

Landslides

A landslide/landslip is primarily a combination of several geological processes that include earth movements like extensive slope failure, rocks falling, and debris flow under the action of gravity. Landslides occur when gravitational and other types of shear stresses within a slope exceed the shear strength (resistance to shearing) of the materials that form the slope.

Causes

Extensive Rainfall: Prolonged and heavy intensity rainfall triggers landslide. If rain duration and pore pressure are high, moderate rainfall can also trigger landslide. A universal landslide survey held in 2003 revealed that 90% of the landslides that occurred were activated by a heavy rainfall.

Melting of Snow: In several cold mountain places, during snowmelt the water produced infiltrates into the earth .This increases pore water pressures, causing the initiation of the landslide process.

Rivers: Rivers can damage the slopes, particularly during the floods triggering a landslide.

Seismic Shaking and volcanic eruption: They cause slope failure triggering landslide.

Deforestation: Roots of plants hold soil particles firmly thereby avoiding soil erosion. But removal of vegetation makes rocks prone to landslides.

Geology: Type of rock or soil such coarse particles have low cohesive strength making it vulnerable to landslide.

Developmental activities: Excavation for minerals, tunnels etc. and road construction can too trigger landslide.

Effects:
Landslides blocks streams with debris and stones, leading to overflowing. It disrupts vehicular movement, damages vegetation, roads, communication networks and buildings. It also results in accidents. Overall it acts as a risk to life. E.g. A massive landslide in 2017 in Himachal Pradesh has killed at least 46 people and injured several others.

Management and mitigation methods:
1) Afforestation: It consolidates the slope thus checking slope instability. Degraded areas should be afforested and existing patches should be preserved.
2) Wired stone blocks: Stone ridge is strapped with wire mesh to protect against landslides.
3) Retaining wall: Construction of concrete retaining walls to prevent slippage from slope.
4) **Landslide hazard zonation mapping**: Zonation mapping will help in preventing settlements in hazard prone area and also developing and continuously updating the inventory of landslide incidences affecting a country.
5) **Surface drainage:** Draining of surface and subsurface rivers to allow smooth flow of water.
6) Landslide Warning Techniques: Sensors have been developed which are used for the landslide warning and detection Early warning systems can disseminate information to masses on time, hereby saving many lives.
7) Managing of catchment: Excess water in catchments areas should be stored to reduce the effect of flash floods, this will also recharge the ground water level in areas prone to landslide in India.

8 Public awareness: An aware and vigilant community can reduce the impact of impending landslides.

Cyclones

Cyclone refers to any spinning storm that rotates around a low-pressure center. The low-pressure center is also referred to as the 'eye' of the storm. It is accompanied by powerful winds blowing anticlockwise in northern hemisphere and clockwise in southern hemisphere. They are known by different names in different countries. Typhoons in northwest pacific ocean, hurricanes in north Atlantic ocean and northeast and south pacific ocean, Tropical cyclones in southwest pacific ocean, southeast and southwest Indian ocean. Willy Willy in Australia Baguio in China Sea, Taifu in Japan and Tornado in South America.

Formation of cyclone

When warm (above 26 °C), moist air over the ocean rises upward, it causes an area of low air pressure below. Air from surrounding areas with higher air pressure pushes in to the low pressure area. Then this new cool air becomes warm and moist and rises too and this cycle continues. As the warm, moist air rises and cools the water in the air forming clouds. The Coriolis effect made by the Earth's rotation causes the

winds to rotate. As the storm system rotates faster and faster, an eye forms in the center. It has little rain or wind. The eye wall maximum rain and the strongest winds. When the winds in the rotating storm reach 39 mph, the storm is called a tropical storm. And when the wind speeds reach 74 mph, the storm is officially a tropical cyclone, hurricane, typhoon or cyclone based on the storm location Tropical cyclones usually weaken when they hit land, because they are no longer being fed by the energy from the warm ocean waters. However, they travel far inland, bringing heavy rain and wind before dying out completely. Cyclone may last from days to week.

Indian cyclones: The 7517 km long coastline of India is world most cyclone affected stretch. Around 8% of the total land area in India is prone to cyclones. West Bengal, Odisha, Gujarat, Andhra Pradesh, Karnataka, Goa and Kerala are the most cyclone affected states of India. E.g. **Cyclone Phailin** originated in Vietnam in October 2013. This cyclone affected Odisha, Jharkhand, West Bengal, Chhattisgarh, Bihar and eastern parts of Uttar Pradesh. A total of 1,34,426 people were eventually evacuated. Power and communication lines went down across many districts. Besides economic losses Odisha recorded casualties of 44 people.

Effects:

Cyclones bring destruction to life and property. It is characterized by heavy rains and strong winds.

1) Storm surge: It is an abnormal rise of sea level near the coast caused by a severe tropical cyclone resulting in inundation of low lying areas of coastal regions. It drowns human beings and live-stock, erodes beaches and embankments, destroys vegetation and reduces soil fertility.

2) Floods: Heavy and continued rains due to cyclones may cause floods and submergence of low lying areas resulting in loss of life and property. Floods and coastal inundation pollute drinking water sources causing eruption of epidemics.

3) Strong winds: Very strong winds may damage infrastructure, dwellings, communication systems, trees etc. vandalizing life and property. It affects normal functioning of life.

4) Crop: It damages crops, which could lead to inflation.

5) Decline in tourist: Tourist will not come to a cyclone affected area, thereby affecting livelihood of people.

6) Storm churn: By churning up cold water, tropical cyclones tend to leave a cold wake behind them that can depress ocean temperature and thus, stifling trailing storm.

7) Psychological impact: Disaster of any kind has long lasting fear on minds of masses. They have witness large number of deaths, collapse of infrastructure, cries, pains and many sorrows.

Management and Mitigation of Cyclones

1) Coastal plantation: Forests act as buffer zone against cyclones. Cyclones travel unchecked in absence of forest. The degraded forests land must be planted as plantation will act as green wall/wind break for cyclones and water flow reduction in storm surges. Mangrove forests shall be managed.

2) Effective weather Monitoring: Cyclones can be predicted several days' before. So, effective weather monitoring and forecast can help in minimizing the losses due to cyclones. Warning messages should be simple and reach in time to the masses.

3) Land Use control: Land use should be such that minimum critical activities carried out in vulnerable areas. Buildings should be water and wind resistant. Retrofitting of the older buildings should be mandatory. There should be maintenance of river embankments. Communication lines should be drawn underground. Construction of strong halls in vulnerable areas.

4) Coastal Regulation Zone norms: They should be strictly enforced.

5) Insurance cover: Comprehensive state insurance cover needs to be provided for persons, their properties and cattle.

6) Preparedness: Coastal areas should have adequate preparedness against cyclones. Wide roads for quick evacuation, disaster resilient buildings, shelter houses etc.

7) Awareness: Focused awareness activities are required to increase public awareness of storm surge, flooding and rainfall related to cyclone.