

MODULE 2

HAZARDS AND VULNERABILITY

SYLLABUS

- Various Hazard types, Hazard mapping; Different types of Vulnerability types and their assessment.
- Vulnerability assessment and types, Physical and social vulnerability.
- Economic and environmental vulnerability, Core elements of disaster risk assessment.
- Components of a comprehensive disaster preparedness strategy approaches, procedures.
- Different disaster response actions.

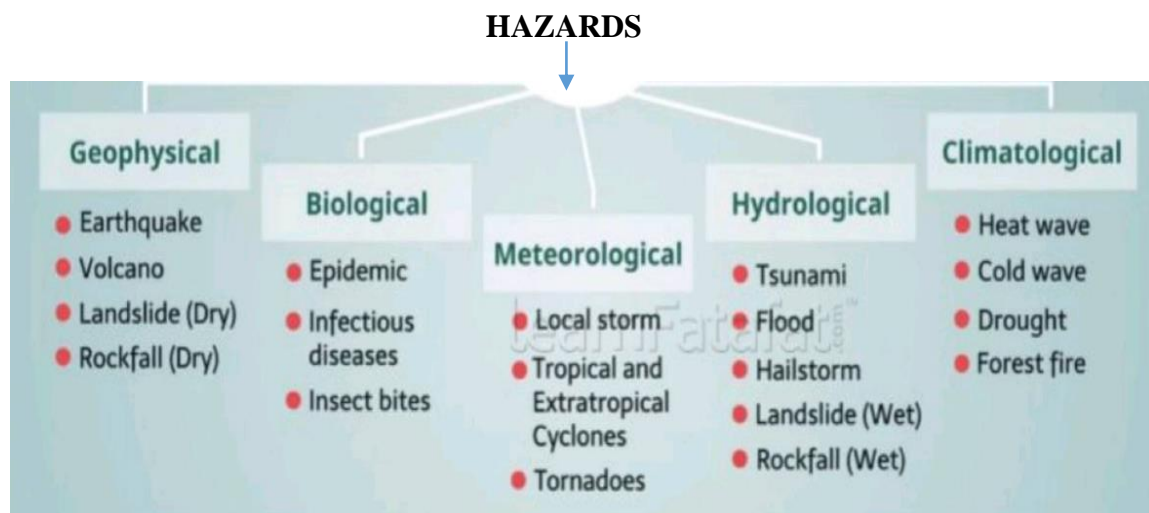
I. HAZARD AND ITS TYPES

HAZARD:

- Hazard is defined as a potential harm or an adverse effect.
- Sometimes the resulting harm is referred to as the hazard instead of the actual source of the hazard.
- Example: The scarcity of water is considered as a hazard-drought
The abundance of water is also a hazard – flood
- Basically, hazard is any object or situation which causes damage to property and environment.

TYPES OF HAZARDS:

- Hazards are classified into 6 major categories
1. Geophysical Hazard
 2. Hydrological Hazard
 3. Meteorological Hazard
 4. Climatological Hazard
 5. Biological Hazard
 6. Extra-terrestrial Hazard



1.Geophysical Hazard

- Hazard which is originating from the earth
- Also known as geological hazard
- Eg:earthquake,volcanic eruption, landslides..

2.Hydrological Hazard

- Hazard which is caused by the occurrence, distribution and movement of water.
- It includes both ground water and surface water
- It includes both fresh water and saline water
- Due to extra scarcity or extra abundance of water
- Eg: tsunami, flood etc...

3.Meteorological Hazard

- Hazard which is caused by weather and atmospheric conditions.
- Short lived, micro to meso- scale hazard.
- Lasts from minutes to days.
- Eg: cyclones, local storm etc...

4.Climatological Hazard

- Hazard which is caused by extreme weather and climate change.
- Long lived, meso to macro scale hazard.
- Lasts from seasons to decades.
- Eg: Heat wave, cold wave drought...

5.Biological Hazard

- Hazard which is caused due to biological agents.
- Caused by the exposure to living organisms or toxic substances
- Also caused by pathogens or vector borne diseases.
- Eg: covid , nipah etc...

6.Extra terrestrial Hazard

- Caused by asteroids, meteoroids and comets ,when they passes near the earth, enter the earth's atmosphere or strikes the earth.

II. HAZARD MAPPING

- Hazard mapping involves graphical representation of the location, magnitude and temporal characteristics of the hazard on 2 or 3 dimensional surfaces.
- Objectives of hazard mapping:
 - 1) To represent spatial and temporal characteristics of the hazard.
 - 2) To represent the magnitude of hazard using graphical symbols.

Data Requirements of Hazard Mapping:

- Spatial characteristics such as location, distribution and dimension ; temporal characteristics and magnitude are the major data requirements for hazard mapping.
- Such information can be obtained through the following sources:
 - 1) Base maps
 - 2) Remotely sensed images
 - 3) Field Data.

1) Base Maps:

- Base maps represent topographic layers of the data such as elevation, roads, water bodies, cultural features and utilities.
- Creation of a base map is a time consuming activity.
- It is therefore desirable to use an existing map.
- It must also have sufficient geographical information and about the location of the hazard.

2)Remotely sensed images:

- Satellite images are becoming preferred sources of readily available information of locations on the earth's surface as compared to conventional ground survey methods of mapping, that are labour intensive and time consuming.
- Geo Eye,QuickBird and ALOS-PRISM are preferred sensors for visual mapping as they are high spatial resolutions.

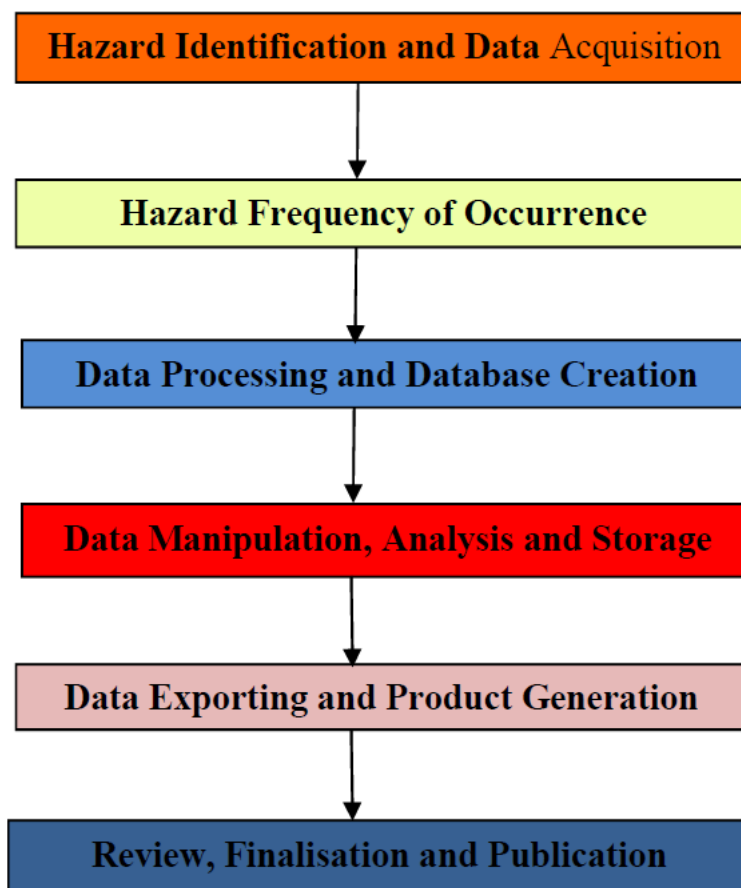
3)Field Data:

- Through the advances in technology, ground surveying using electronic systems like total station, global positioning system (GPS), and laser scanners have increased opportunities for data capture in the field.

➤ APPROACHES TO HAZARD MAPPING

1)Hazard Mapping using geographical information system:

- GIS is increasingly used for hazard mapping and analysis , as well as for the application of disaster risk management measures.
- The nature and capability of GIS provides excellent basis for processing and presenting hazard information in the form of maps.
- GIS is very useful in arranging a high volume of data to produce a hazard map.
- Flowchart represents general procedures for the mapping of hazards in GIS.



GIS mapping of hazards

2) Participatory mapping

- Participatory mapping is a technique that allows for the integration of local level participation and knowledge in the map production and decision taken process.
- It is an interactive process that draws on local people's knowledge and allows them to create visual and non-visual data to explore social problems, opportunities and questions.
- In participatory mapping, the main objectives are to:
 - collect evidence of the study area
 - Interpret the study area mapping experience and related experience to answer questions that have been developed about the study area.
 - develop a presentation that synthesises the participatory mapping experience
 - Present the conclusion and possible questions for further investigation.

How to Conduct Participatory Mapping

- Stage 1: outline the nature and essence of activities to be done.
- Stage 2: preparation and implementation.
- The preparation involves 'scouting' and 'designing survey instrument, materials and directions'.
- The implementation may be organised into sessions (usually four) -
- Preparation of participants or people involved in the participatory mapping activity; undertake participatory mapping field trip; make presentations and carry out debriefing exercises.

Applications of Hazard Maps:

- **Spatial planning:** Hazard maps provide a basis for communal and district spatial planning processes
- **Risk reduction measures:** Hazard maps assist in the localisation and dimensioning of hazard protection measures.
- **Emergency planning:** Hazard maps indicate where the biggest risks arise and the events most likely to occur. This information can be used as a source of orientation in emergency planning.
- **Raising awareness among the population:** Hazard maps help to demonstrate potential risks to the population and to increase awareness of eventual protective measures.

III. VULNERABILITY.

- Vulnerability is **the inability to resist a hazard or to respond when a disaster has occurred.** For eg:, people who live on plains are more vulnerable to floods than people who live higher up.

- It the degree to which a system is exposed and susceptible to adverse effect of a given hazard
- $\text{Vulnerability} = \text{Exposure} + \text{Resistance} + \text{Resilience}$.
- Exposure: property and population at risk
- Resistance : measures taken to prevent, avoid or reduce loss
- Resilience: ability to recover prior state or achieve post disaster state.

➤ **Types of Vulnerability:**

- There are mainly 4 types of vulnerability, they are:
 - 1) Physical Vulnerability
 - 2) Social Vulnerability
 - 3) Economic Vulnerability
 - 4) Ecological or environmental vulnerability

1) Physical Vulnerability

- This refers to the potential losses to the physical infrastructure such as roads, bridges, railways, radio and telecommunication mast and other features in the built environment.
- It also includes impacts on human population, in terms of injuries or death.
- In short, the vulnerability which occurs physically to property and lives is known as physical vulnerability.

2) Social Vulnerability

- Social vulnerability refers to the losses experienced by the people and their social, economic and political systems.
- It refers to the extent to which, elements of the society such as children, aged, pregnant and lactating women, single parents, family systems, social systems, caste ,gender, cultural values etc.. Will degrade after being exposed to a hazardous condition.

3)Economic Vulnerability

- Refers to the potential impacts of hazards on economic assets and processes and also includes vulnerability of different economic sections.

4) Ecological / Environmental Vulnerability

- Refers to the degree of loss that an ecosystem will sustain to its structure, function and composition as a result of exposure to a hazardous condition.

➤ **Quantifying Vulnerability**

- Used to estimate how much mitigation and preparedness measures will be applied.
- It is based on the data about,previous hazard events and their severity.
- It is expressed as 0 to 1

- 0- indicates lowest degree of vulnerability.
- 1-indicates highest degree of vulnerability.

➤ **Vulnerability Assessment**

- Vulnerability assessment is the process of assessing degree of loss.
- Variation exist in the method of assessing vulnerability, based on the following factors.
 - 1) Type of vulnerability being measured.
 - 2) Scale at which the vulnerability is measured.
 - 3) Type of hazard.

Types of vulnerability assessment:

- 1) Physical vulnerability assessment
- 2) Socio economic vulnerability assessment
- 3) Environmental or ecological vulnerability assessment

1)Physical vulnerability assessment:

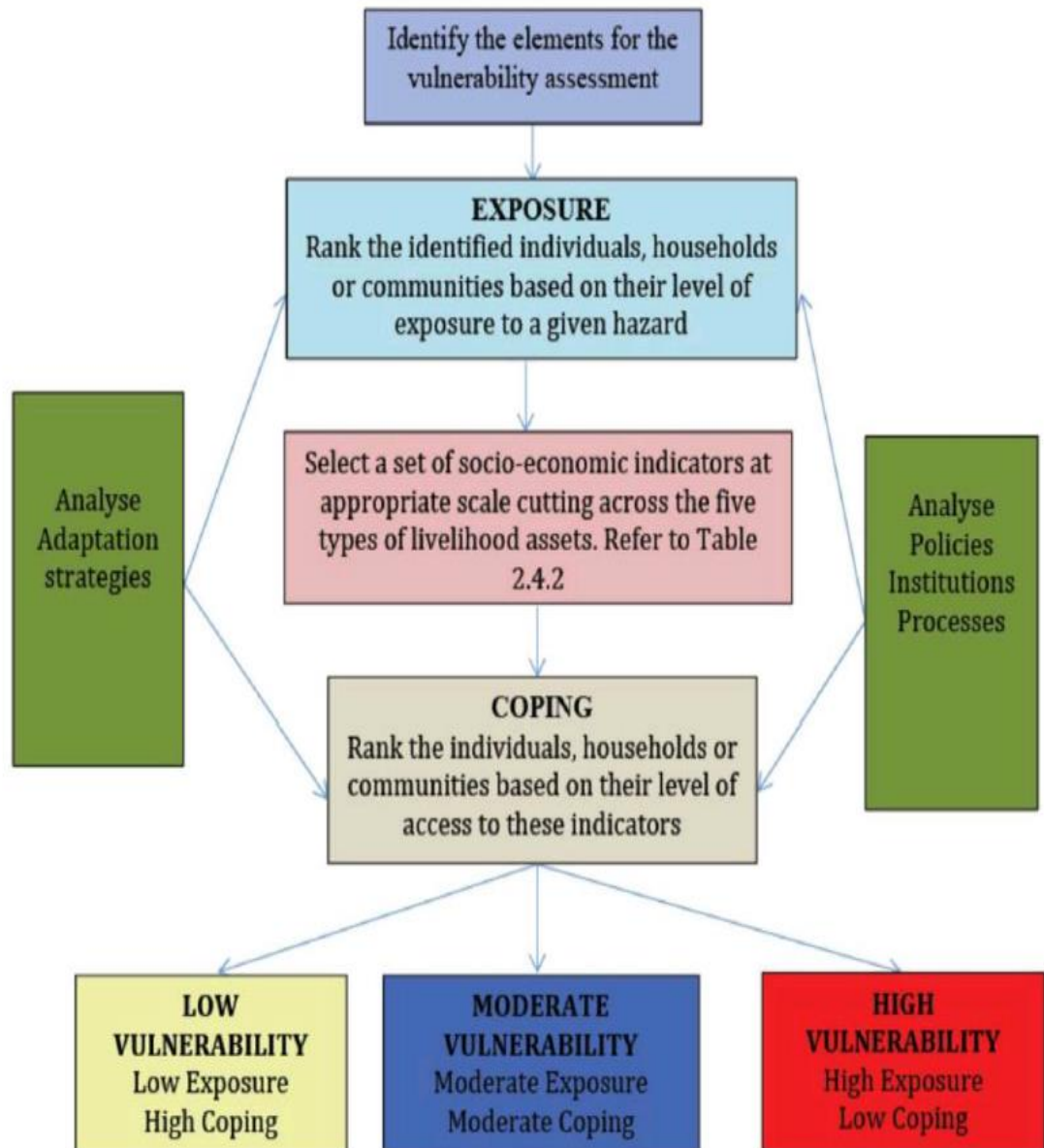
- There are many ways to assess physical vulnerability.
- Two main methods are empirical method and analytical method.
- Empirical method can be applied to groups of related structures.
- Analytical method are based on the use of geotechnical engineering software and are limited to individual structures.

Group	Method	Description
	Analysis of observed damage	Based on the collection and analysis of statistics of damage that occurred in recent and historic events. Relating vulnerability to different hazard intensities.
Empirical methods	Expert opinion	Based on asking groups of experts on vulnerability to give their opinions, e.g. the percentage damage they expect for the different structural types having different intensities of hazard. This is meant to come to a good assessment of the vulnerability. Method is time consuming and subjective. Re-assessments of vulnerability after building upgrading or repair are difficult to accommodate.
	Score Assignment	Method using a questionnaire with different parameters to assess the potential damages in relation to different hazard levels. The score assignment method is easier to update, e.g. if we think about earthquake vulnerability before and after application of retrofitting.

Analytical models	Simple Analytical models	Studying the behaviour of buildings and structures based on engineering design criteria, analysing e.g. seismic load and to derive the likelihood of failure, using computer based methods from geotechnical engineering. Using, e.g. shake tables and wind tunnels, as well as computer simulation techniques.
	Detailed Analytical methods	Using complex methods. It is time consuming, needs a lot of detailed data and will be used for assessment of individual structures.

2)Socio-Economic vulnerability assessment.

- Socio-economic vulnerability is indicator based.
- It can be assessed by analysing the level of exposure and coping mechanisms of individuals, households and communities.
- Assessment procedure:

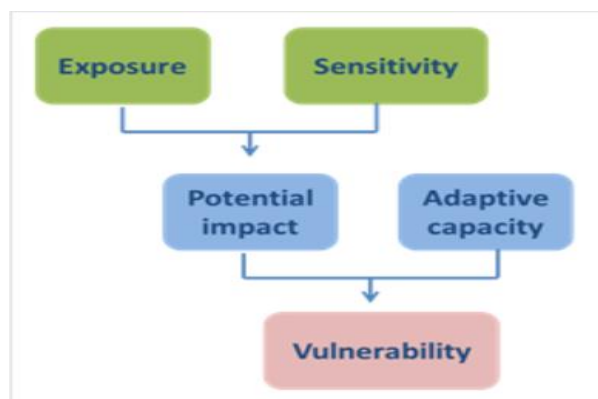


- **Socio-economic indicators:**

Human Capital	Natural Capital	Social Capital	Physical Capital	Financial Capital
Health	Land and produce	Networks and connections	Infrastructure <ul style="list-style-type: none"> • Transport - roads, vehicles, etc. • Secure shelter & buildings • water supply & sanitation 	Savings
			• Energy communications	
Nutrition	Water & aquatic resources	Patronage	Tools and technology <ul style="list-style-type: none"> • Tools and equipment for production • Seed, fertiliser, pesticides • Traditional technology 	Credit/debt - formal, informal, NGOs
Education	Forest products	Neighbourhoods		Remittances
Knowledge and skills	Wildlife	Kinship		Pensions
Capacity to work	Wild foods & fibres	Relations of trust and mutual support		Wages
Capacity to adapt	Biodiversity	Formal and informal groups		Dividends
	Environmental services	Common rules and sanctions		Return on Investments

3)ecological or environmental vulnerability assessment:

- The environmental vulnerability assessment is used for the comprehensive evaluation of the resource system affected by natural conditions and intervened by human activities .



➤ **Data's needed for vulnerability Assessment:**

- **Historical Data:** previously occurred hazard datas,represents the magnitude of a hazard and the level of damage it caused.
- **Socio-Economic Data:** such as level of education, social networks,sanitation,land income, etc...
- **Level of exposure data's, on hazard condition.**
- **Data's on policy, institution and process,** which influence capacity of individuals, households and communities.

➤ **Methods of representing Vulnerability:**

- 1) Vulnerability indices: based on indicators of vulnerability.
- 2) Vulnerability Table: tabular representation of vulnerability, which indicates relation between hazard intensity and degree of damage.
- 3) Vulnerability Curves: graphical representation of vulnerability, which indicates relation between hazard intensity and degree of damage.
 - Relative curves: shows percentage of property value as the damaged share of total value to hazard intensity.
 - Absolute curves: shows the absolute amount of damage depending on the hazard intensity
 - Fragile curves: provides probability of a particular group of elements at risk.

IV. DISASTER RISK ASSESSMENT:

➤ **Disaster risk**

- It is the probability of serious damages, death and injuries occurring as a result of a potentially damaging hazard, when interacting with vulnerable elements such as people and properties.



➤ **Disaster Risk Assessment:**

- A qualitative or quantitative approach to determine the nature and extent of disaster risk by analysing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend.

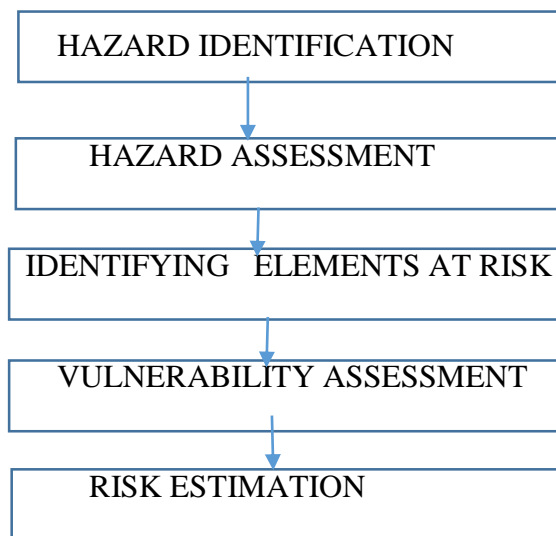
Components of risk Assessment:

There are 2 main components:

- 1) Risk Analysis.
- 2) Risk Evaluation:

1) Risk Analysis:

- The use of available information to estimate the risk caused by the hazard to individuals, population.
- It contains the following steps:



2)Risk Evaluation

- This is the stage at which values and judgements are entered for the decision making process.
- It includes all the results of risk associated with social, economic and environmental.

➤ **Contemporary approaches to risk assessments**

1) MULTI-HAZARD:

- Same area may be threatened by different types of hazards.

- Each hazard types are impacted by different hazard scenarios. Each of the hazard scenarios also might have different magnitudes.
- E.g.: water depth and velocity in the case of flooding, acceleration and ground displacement in the case of earthquakes.
- These hazard magnitudes would also have different impacts on the various elements at risk, and therefore require different vulnerability curves.

2) MULTI-SECTORAL:

- Hazards will impact different sectors of elements at risk.

3) MULTI-LEVEL

- Risk assessment can be carried out at different levels.
- Different levels include national, regional, district and local policies.
- It also defines what resources are available at the different levels to reduce risks.

4) MULTI-STAKEHOLDER

- Risk assessment should involve the relevant stakeholders, which can be individuals, businesses, organisations and authorities.

5) MULTI PHASE

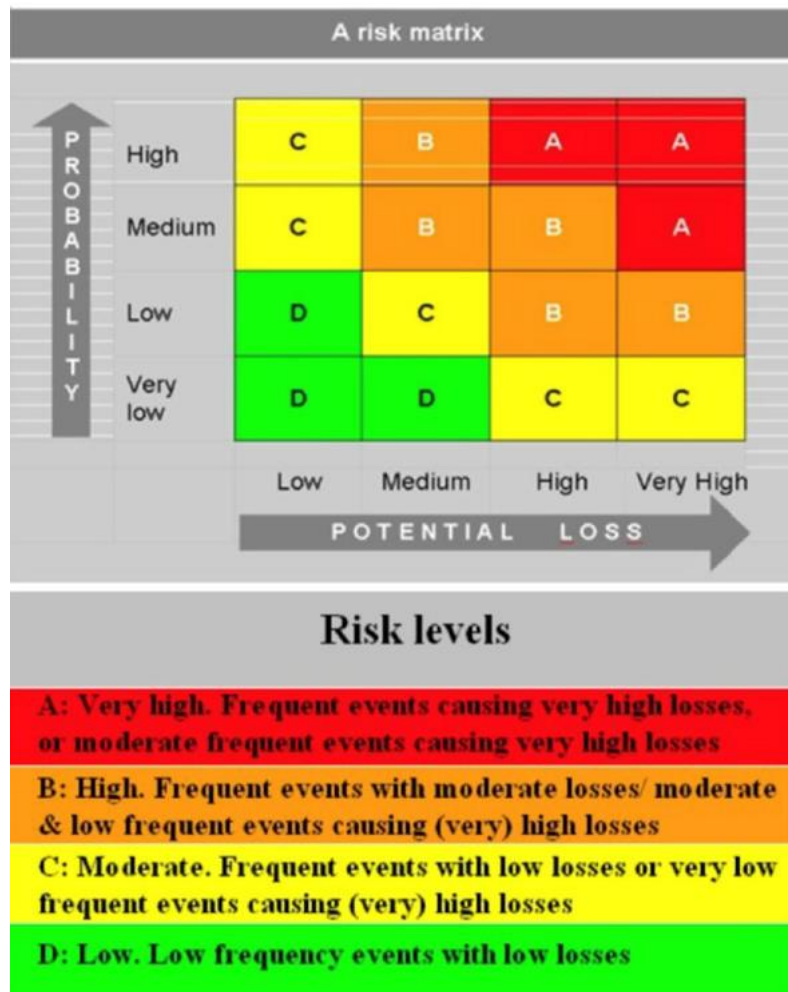
- It consist of various phases of risk assessment such as response, recovery, mitigation and preparedness.

➤ **Risk Assessment Methods:**

- 1) Qualitative methods
- 2) Semi –quantitative methods
- 3) Quantitative methods.

1) Qualitative Risk Assessment

- This involves qualitative descriptions of risk in terms of high, moderate and low.
- These are used when the hazard information does not allow us to express the probability of occurrence, or it is not possible to estimate the magnitude.
- This approach has widespread application in the profiling of vulnerability using participatory methodologies.
- Risk matrices can be constructed to show qualitative risk.
- A risk matrix shows on its y-axis probability of an event occurring, while on the x-axis potential loss.



2) Semi-Quantitative Risk Assessment.

- These techniques express risk in terms of numerical values.
- Ranging between 0 and 1
- They do not have a direct meaning of expected losses; they are merely relative indications of risk.
- The semi quantitative estimation for risk assessment is found useful in the following situations:
 - As an initial screening process to identify hazards and risks
 - When the level of risk (pre-assumed) does not justify the time and effort
 - Where the possibility of obtaining numerical data is limited
- The semi-quantitative approach could be adapted to cover larger areas.

3) Quantitative methods.

- This aims at estimating the spatial and temporal probability of risk and its magnitude.

- In this method, the combined effects, in terms of losses for all possible scenarios that might occur, are calculated.

$$\text{Risk} = \text{Hazard} * \text{Vulnerability} * \text{Amount of elements-at-risk}$$

- The equation given above is not only a conceptual one, but can also be actually calculated with spatial data in a GIS to quantify risk from hazards.
- The hazard component in the equation actually refers to the probability of occurrence of a hazardous phenomenon with a given intensity within a specified period of time.

V.DISASTER PREPAREDNESS:

Disaster preparedness involves the knowledge and practices developed by governments, communities and recovery organisations for effectively responding and recovering from the impacts of hazard.

Types of Disaster Preparedness

Disaster preparedness can be studied under three specific categories:

- ❖ *Target-Oriented Preparedness:* Preparedness plans may be target specific, for instance, we may require different types of planning for the vulnerable groups of women, children, elderly and disabled.
- ❖ *Task-Oriented Preparedness:* Specific groups jointly develop activities based on one of the community's plans to evaluate the community's capability to activate the preparedness plan in a real emergency. Eventually, these tasks enable the development of plan revisions, employee training and material resources to support readiness.
- ❖ *Disaster-Oriented Preparedness:* This addresses the likelihood of occurrence of a specific disaster. Emphasis is placed on structural and non-structural mechanisms.

➤ **Components of a Comprehensive Disaster Preparedness Strategy:**

The essential elements include the following:

- ☐ Hazard, risk and vulnerability assessments
- ☐ Response mechanisms and strategies
- ☐ Preparedness plans
- ☐ Coordination
- ☐ Information management
- ☐ Early warning systems
- ☐ Resource mobilisation

- ☐ Public education, training & rehearsals
- ☐ Community-based disaster preparedness

VI.DISASTER RESPONSE

- Disaster responses are the set of activities taken during a disaster or immediately following a disaster, directed towards saving life and protecting property.
- The activities that deal with the effect of disaster may include medical care, evacuation, Search and rescue, provision of emergency water, food and shelter, debris removal and stabilisation of unsafe buildings and landforms.
- It is the second phase of the disaster management cycle.

➤ **Objectives of Disaster Response:**

- Aimed at providing immediate assistance to maintain life, improve health and support the affected population.
- Focused at meeting the basic needs of the people until more permanent and sustainable solutions can be found.
- Preparedness for the first and immediate response is referred to as “emergency preparedness”

➤ **Factors affecting Disaster Response:**

- The type of disaster
- The ability to take pre-impact actions
- The severity and magnitude of disaster
- The capability of sustained operations
- Identification of likely response requirements

➤ **Different Disaster Response actions:**

Disaster response actions are classified into 10 types:

1. Search and rescue
2. First aid and emergency medical care
3. Evacuation
4. Evacuation centre management
5. Development of Standard Operation Procedure (SOPs)
6. Immediate repair of community facilities and services
7. Relief Aid
8. Coordination and Communication

9. Psycho-social counselling and stress debriefing
10. Medical services.

1. Search and rescue

- This activity is usually conducted by well-trained volunteers in finding disaster victims, that is, lost, sick or injured persons in either a remote to access areas such as water bodies, desert, forest or probably in the course of mass population movement.
- The search and rescue operations are often directed at, locating endangered persons at an emergency incident, removing those persons from danger, treating the injured, and providing for transport to an appropriate health care facility.

Basic Key Steps of Search and Rescue:

The basic steps are:

- 1. Size up** - involves assessing the situation and determining what one is going to do and if yes, then how. The decision whether to attempt a rescue should be based on:
 - a. The risks involved; and
 - b. formation of each volunteer teams.
- 2. Search** - involves locating victims and documenting their location.
- 3. Rescue** - involves the procedures and methods of moving victims to safety.

2. First aid and emergency medical care

- First aid is the provision of initial care for an illness or injury.
- It is usually performed by non-expert, but trained personnel to a sick or injured person until definitive medical treatment can be accessed.
- Emergency medical care is immediate paramedic attention to severe wounds and the rapid transportation of the ill or injured to a health facility.

3. Evacuation

- Evacuation is an organised movement of people from an area at risk to a safer place.
- Types of Evacuation:
 - Precautionary evacuation before disaster
 - Protective evacuation after disaster
 - Evacuations for reconstruction purposes
- Services provided during evacuations include:
 - ✓ Registration
 - ✓ Assistance with financial and legal queries

- ✓ Water, food, clothing
- ✓ Rest areas
- ✓ Blankets and personal items
- ✓ Interpreter services
- ✓ Assistance in contacting family/friends
- ✓ Services for animals
- ✓ Emergency financial assistance
- ✓ First aid, medical and health
- ✓ Information

4. Standard Operating Procedures (SOPs).

- SOPs are the set of standard procedures which could guide the team in effective operation.
- SOPs specify the way in which individuals or units will carry out their functions under the plan
- It consist of 4 stages:
 - 1) During normal times
 - 2) Alert/warning and
 - 3) During disaster
 - 4) Rehabilitation

During Normal Times:

- Formulate and distribute disaster preparedness plans
- Produce maps of Wards/Village Tracts showing areas most vulnerable to disasters.
- Make a list of vehicles and motor boats that can be used for emergency work
- Create shelters and safe locations for use during disasters
- Conduct educational talks on natural disasters and rehearse periodically for the local community
- Provide organising and training activities.

Alert/warning stage:

- Dissemination of news obtained through early warning systems to the community.
- Administrative bodies and NGOs to fly warning flags in the vulnerable areas of the Ward/Village Tract.
- Alert and mobilise members of the Security services, Auxiliary Fire Brigade, communication agencies, the Red Cross, Youth, members of People's Strength and NGOs.

- Make the necessary arrangements to evacuate the public to safe locations

During Disaster Stage:

- Safeguard the road and water transport routes
- Evacuate the community from vulnerable areas to safe locations
- Operate relief camps and supervisory centres
- Keep available relief and aid supplies at the ready to launch relief operations quickly and effectively
- Make arrangements to evacuate movable property including cattle to designated locations
- Ensure that administrative personnel and NGOs in areas vulnerable to disaster and give disaster warnings door to door.

During Rehabilitation Stage:

- Conduct field inspections in affected areas as soon as possible and provide the necessary assistance and support.
- Make arrangements to provide health care and social protection to disaster victims.
- Clear collapsed buildings and trees as quickly as possible;
- restoration of transportation, electricity and water supply and telephone and telegraph services as soon as possible.
- reclaim contaminated wells and ponds for access to clean water and dig new wells for drinking water.
- Submit immediate preliminary reports with population figures, death and injury figures of cattle and animals, data on socio-economic losses, etc.. to get appropriate funds.
- Manage and systematically utilise disaster funds and supplies, as well as cash and supplies donated by well-wishers, social organisations and NGOs

5. Relief Aid

- provision of assistance during an emergency that is meant to attend to a person's immediate requirements for survival or recovery
- It may include food, clothing, housing, medical care, necessary social services and security.
- Relief aid must be targeted at the most vulnerable first: Vulnerable children or orphans, females, pregnant women, sick or elderly populations.

6. Coordination and Communication

- Good coordination and communication is crucial for combining resources effectively and efficiently, in order to reach the disaster-affected more rapidly.
- It contributes to better cooperation, reduces the level of duplication and helps to ensure a well-organised operation.
- **Meetings** - Plan to hold regular meetings with Movement partners to determine activities and roles;
- **Information management** - Information sharing on disaster impact, assessment and needs through input into DMIS (Disaster Management Information System).

7. Psychosocial support:

- During a disaster, many may lose not only properties, but also dear ones which cause negative psychological outcomes.
- Psychosocial support activities include identifying and referring individuals requiring specialised support through professional mental health services.

8. Public health services:

The public health services required in responding to disasters include:

- ☐ Mass casualty management
- ☐ Mental health
- ☐ Managing and continuation of existing health services.
- ☐ Managing and continuation of medication on chronically affected diseases (HIV, TB, Leprosy, etc.)
- ☐ Management of the dead and missing.
- ☐ Emergency feeding.
- ☐ Communicable disease surveillance and response
- ☐ Sanitation.

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