CERTIFICATE PROGRAMME IN
DISASTER AND EMERGENCY MANAGEMENT

CDEM 02

UNDERSTANDING VULNERABILITY AND RISK

GPD School of Interdisciplinary and Vocational Studies
KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY

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COURSE INTRODUCTION: UNDERSTANDING VULNERABILITY AND RISK

"Understanding Vulnerability and Risk" is the second course of the Certificate programme in Disaster and Emergency Management. This course has been designed to understand the rationale and significance of vulnerability and risk of disasters. Understanding vulnerability and risk is essential in disaster management to effectively assess, mitigate and respond to potential hazards and disasters. Vulnerability represents the potential for loss of life and property resulting from exposure to hazards. On the other hand, risk refers to the probability of hazardous event occurring and the impacts associated with it. Both are interconnected concepts and play an important role in the field of disaster management. Vulnerability influences the level risk that communities, individuals or systems face when expose to hazards. This course emphasizes in understanding the relationship between vulnerability and risk their overall assessment and mitigation measures to reduce vulnerability and manage risk that leads to more resilient communities and systems.

There are eight units in the course. A brief outline of each unit is mentioned in the succeeding text.

The **first unit** deals with the basic understanding of vulnerability and risk, significance of vulnerability and risk.

The **second unit** explains the concept of vulnerability, identification of vulnerability and types and factors of vulnerability.

The **third unit** aims to explain risk types and elements, relation among hazard, risk and reduction of vulnerability

The **fourth unit** refers to the understanding of vulnerability and risk assessment, vulnerability analysis, risk analysis, and risk mapping.

The **fifth unit** focuses on disaster related vulnerability and sustainable development for vulnerability reduction.

The **sixth unit** covers the meaning of disaster management, disaster management cycle, crisis management and risk management.

The **seven unit** includes Institutional Framework for Disaster Management in India, Disaster Management Act, National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), District Disaster Management Authority (DDMA), Disaster Management Authorities at Local Level

The **eighth unit** discusses the Idea of Disaster Risk Reduction, Mitigation Measures of Structural and Non- Structural disaster events.

While going through a unit, you will notice some boxes, containing such information as would help you to understand some of the difficult, unfamiliar terms. You will find an item called "ACTIVITY' where you will apply your knowledge and thoughts in some questions pertaining to the relevant topic. Again, we

have included some relevant concepts in "LET US KNOW" along with the text. And, at the end of each seection, you will get "CHECK YOUR PROGRESS" questions. These have been designed to self-check your progress of study. It will be better if you solve the problems put in these boxes immediately after you go through the sections of the units and then match your answers with "ANSWERS TO CHECK YOUR PROGRESS" given at the end of each unit.

UNIT- 1 : BASICS OF VULNERABILITY AND RISK

UNIT STRUCTURE

1.1 Learning Objectives

1.2 Introduction

1.3 Meaning of Vulnerability and Risk

1.4 Significance of Vulnerability and Risk

1.5 Let us Sum up

1.6 Further Readings

1.7 Answers to Check Your Progress

1.8 Model Questions

1.1 LEARNING OBJECTIVES

After reading this unit, you will be able to-

- describe the meaning of vulnerability and risk
- enlighten the significance of vulnerability and risk

1.2 INTRODUCTION

This unit marks the beginning of the second course where we will focus on the fundamentals of vulnerability and risk. It will cover the definitions of vulnerability and risk, as well as their respective significance.

1.3 CONCEPT OF GEOINFORMATICS

Hazards and disasters, whether natural or man-made have assumed larger proportion at global, regional and local levels after industrial revolution due to a host of causal factors. The ever-increasing human activities have augmented both frequency and severity of natural hazards and disasters such as tropical storms, river floods, landslides, reservoir-induced seismic events, accelerated soil erosion, global warming and climate change etc.

Disasters not only cause casualties but also lead to significant economic and financial losses. These losses stem from damage and destruction across various sectors: agriculture suffers from droughts and floods; buildings sustain damage; public infrastructure such as transportation, communication networks, supply chains, and electricity distribution systems are affected. Businesses and industries also experience substantial losses as a result.

These losses have adverse macroeconomic side effects on growth of Gross Domestic Product (GDP); government budgets; balance of payments; income distribution; income generation; poverty levels etc. All these adversely impact the economic development of the affected countries.

The response to hazards and disasters has evolved over a period of time from relief-centric approach to more holistic approach comprising pre and post disaster elements of management i.e. disaster preparedness, mitigation and prevention, rescue and relief, rehabilitation and recovery. Hazards may be defined as those extreme events either natural or man-induced which occur rarely and exceed the tolerable magnitude within or beyond certain time limits, make human adjustments very difficult result, in colossal losses of property, human and animal lives, destruction of settlement and vegetation etc.

Disasters, whether natural and anthropogenic are sudden adverse unfortunate extreme events or hazards which cause great damage to human beings as well as plants and animals. Disasters may occur rapidly, instantaneously and indiscriminately.

A hazard may or may not be a clue to an event, or the event in itself may or may not cause damage. Such possibilities are controlled by the vulnerability of 'elements' at risk. Vulnerability is the magnitude to which an 'element' (animate/inanimate) is affected in the event of a disaster. 'Elements' are detected as life and property likely to undergo damage in the event of a disaster. Inspection and perception of risk involves, specifically, such 'elements' at risk. Identifying risk involves examining the specific natural, technological, or chemical processes that contribute

to the vulnerability of the elements considered in the risk analysis. Vulnerability can be natural or man-made. It can be physical, owing to factors such as weak buildings, habitation in hazard prone areas; or socio economic, evolving due to poverty or disregarding of the weaker sections of society who lack the means of protecting themselves in the event of a disaster. Above mentioned concepts are discussed below in detail.

The term vulnerability has been derived from Latin word **'vulnerabilis'** meaning thereby **'to wound'** or **'to harm'**. According to D.P.Coppola (2011) "vulnerability is a measure of the propensity (natural tendency) of an object, area, individual, group, community, country or other entity to incur the consequences of a hazard. This measurement results from a combination of physical, social, economic and environmental factors or processes."

Question arises as to who is susceptible to a disaster?

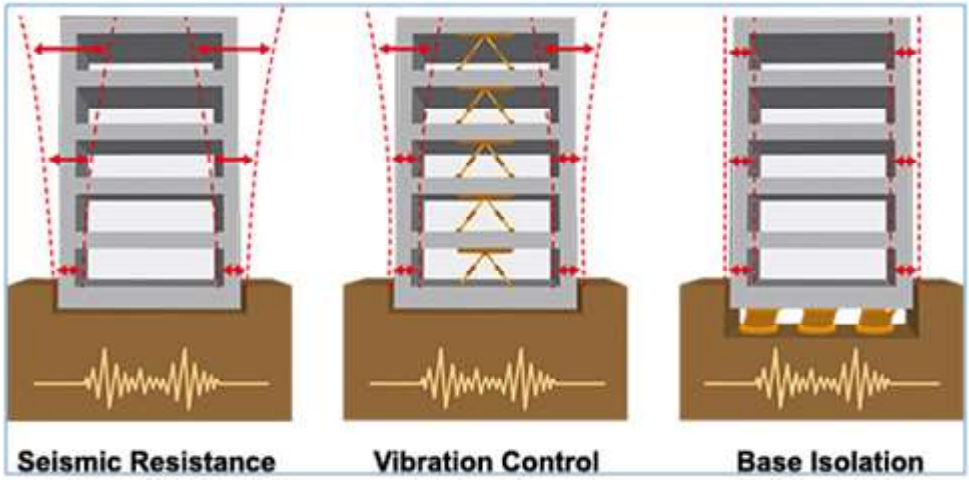
The answer is, it may be spatial unit (be it a specific location, or a region or a country or even larger area, flood plain, coastal area, marine ecosystem etc.), human community, plant community and animal community.

The WCDR (World Conference on Disaster Reduction, 2005) has adopted the following definition of vulnerability:

Vulnerability denotes the "conditions determined by physical, social, economic and environmental factors or processes, which increase susceptibility of a community to the impacts of hazards. Vulnerability is thus the probability of being damaged, destroyed or lost because of a natural hazard. Vulnerability is far from being a static process; it is dynamic process that keeps on changing the probability of process of loss and damage of all the elements exposed to disasters.

Hazard vulnerability can be increased by reducing the tendency of a hazard to inflict harm to humans and their establishments or it can be increased by increasing the tendency of a hazard to incur harm to an object through increased human activities which are detrimental to human society.

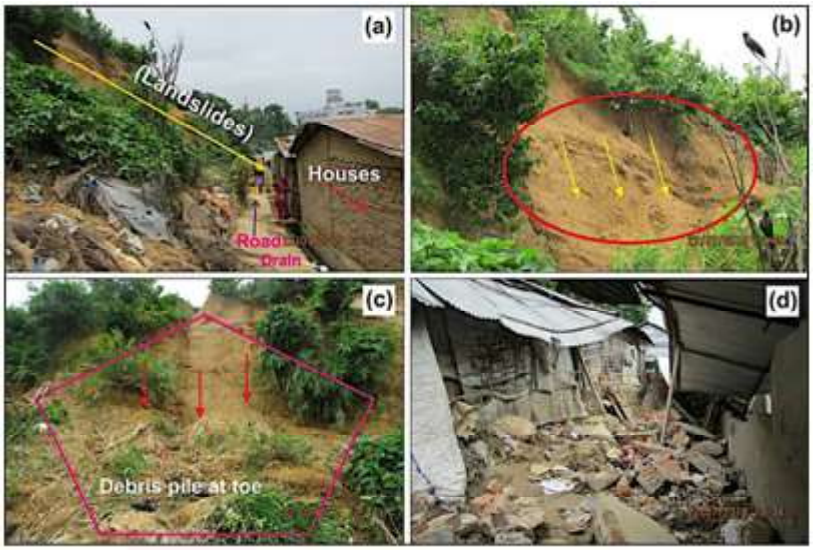
Example 1: construction of earthquake-resistant buildings by following standard building codes in earthquake prone area lowers the tendency (propensity) of an event to incur harm to such buildings and hence also decreases the vulnerability of such buildings to an earthquake.



Source: https://www.indiacadworks.com/blog/new-generation architectural-designs-for-seismic-resistant-buildings/

Fig. 1.1: Key considerations for earthquake proof buildings

Example 2: construction of building on unstable hillslopes which are prone to landslides and are in high seismic risk zone, increases the vulnerability of such buildings to seismic and landslide hazards.



Source: https://www.researchgate.net/figure/Landslides-in-the-Lalkhan-Bazaar-area-Chittagong-City-Corporation-CCC-Bangladesh-a_fig1_315523

Fig. 1.2: Landslides in the Lalkhan Bazaar area, Chittagong City Corporation (CCC), Bangladesh. (a) Location of vulnerable houses; (b) landslide scar; (c) landslide deposit; and (d) destroyed houses. Source: Fieldwork, July 2015

A risk is defined as an adverse impacts of a particular hazard on different aspects such as social, economic, political, medical, psychological etc., of human society.

"A risk is the probability that a hazard will happen or more precisely the likelihood that an event will coincide with elements which can be affected" (C. J. Barrows, 2005).

Hazard/disaster risk is a probability of likely adverse impacts of a particular hazard on society, it is full of uncertainties in terms of magnitude and severity of a hazard, speed, quantum of likely damage, duration of persistence of disaster etc.

Risk has different connotations and definitions in different disciplines e.g., environmental science, ecology, economies, engineering and technology, toxicology etc. A few examples are given below:

According to common connotation disaster risk is defined as:

Risk = Hazard * Vulnerability * Amount

Where Hazard= Probability of event with a certain magnitude (triggering mechanism, type of event, magnitude: volume, domino effect, distance, duration, speed etc.)

Vulnerability= Degree of damage. Function of: (magnitude of event and type of elements at risk)

Amount= Quantification of the elements at risk e.g. (replacement costs of buildings or infrastructure, loss of function or economic activities, number of people)

Risk is viewed in terms of human health and wealth; or it is viewed in terms of environment and nature.



CHECK YOUR PROGRESS

Q.1: Define Disaster.

.....

Q.2: Define Risk.

.....

Q.3: What is Vulnerability?

.....

1.4 SIGNIFICANCE OF VULNERABILITY AND RISK

Vulnerability refers to the population's capacity to predict, cope with, and recover from the impact of a hazardous event. A hazard vulnerability assessment (HVA) scientifically evaluates the damage that could be caused by a possible disaster, the severity of the impact, and the available medical resources during a disaster to reduce population vulnerability and increase the capability to cope with disasters.

Analysis of vulnerability advancement helps to examine sensitivity of human-environment systems to a variety of social and environmental changes, and their ability to adapt to such changes. Therefore, vulnerability assessment includes perception of exposure, sensitivity and resilience to multiple pressures. The existing vulnerability assessment method and improving disaster consequences is a useful tool in analyzing progress of vulnerability to hazards. For decades, disaster risk assessment was based on hazard assessment only. It is difficult to influence on the hazard events. The reduction in risk may be affected the most by reducing vulnerability. Reduction in vulnerability will lead to reduction in the magnitude of risk. It can be seen that the socio-economic component of disaster affects the process of development of population making it vulnerability vulnerable. This kind of thinking along with alleviating identified pressures creating population vulnerability (root causes, dynamic pressures and conditions of uncertainty) contributes real disaster risk reduction and efficient disaster risk management cycle.

Geographic Information System (GIS), aerospace survey and satellite images help considerably in identifying and mapping of vulnerably areas in obtaining historic information gathered from local people and transmitting such information to researchers to better model the frequency and magnitude of events in an area. The detailed analysis of the vulnerable areas affected in the past and likely to be affected in near future by a particular hazard and disaster, of mass data set regarding the frequency, recurrence intervals of major events, magnitude and severity of hazards and disasters, physical, infrastructural, community and social vulnerability, social and governmental reactions and responses to hazards and disasters, adjustment of society to the hazards and disasters is of vital importance in the mitigation and reduction and future management of disasters.

The importance Risk management is necessary to identifying, assessing and controlling threats to any events. These risks stem from a variety of sources, including financial uncertainties, legal problems, technology issues, unplanned management errors, accidents and natural disasters. A successful risk controlling program helps an organization consider the full range of risks it faces. Risk management also examines the relationship between risks and its impact. The economic and financial losses inflicted by disasters can be reduced by adopting suitable risk mitigation measures. For example, the flood disaster risk can be mitigated by construction of bunds along river banks, proper management of irrigation canals, better watershed management to reduce runoff from deforested upstream slopes etc. Similarly, the risk of cyclone disasters to wooden houses can be mitigated by having thicker roof sheet and better fastening, stronger doors and windows, risk of earthquake can be mitigated by retrofitting old buildings and adopting stricter building codes for new buildings.



CHECK YOUR PROGRESS

Q.4: What Is vulnerability assessment?

.....

Q.5: What do you mean by risk assessment?

.....

Q.6: When should a risk assessment be done?

.....



1.5 LET US SUM UP

- The basic elements of natural disaster reduction and management include the study and analysis of the nature of hazards in terms of their origin, magnitude and severity.
- Vulnerability is the magnitude to which an 'element' (animate/ inanimate) is affected in the event of a disaster
- Identifying risk involves examining the specific natural, technological, or chemical processes that contribute to the vulnerability of the elements considered in the risk analysis.
- Vulnerability is dynamic process that keeps on changing the probability of process of loss and damage of all the elements exposed to disasters..
- A risk is defined as an adverse impacts of a particular hazard on different aspects such as social, economic, political, medical, psychological etc., of human society.
- According to common connotation disaster risk is defined as Risk = Hazard * Vulnerability * Amount
- The importance Risk management is necessary to identifying, assessing and controlling threats to any events.



1.6 FURTHER READINGS

1. *Ayaz, Disaster Management: Through the New Millennium. Anmol Publications. (2009)*
2. *Dave, P. K. Emergency Medical Services and Disaster Management: A Holistic Approach. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd., 2009*
3. *Narayan, B. Disaster Management, New Delhi: A.P.H. Publishing Corporation ,2009*
4. *Kumar, N. Disaster Management. New Delhi: Alfa Publications., 2009*
5. *Ghosh, G. K., Disaster Management. New Delhi: A.P.H Publishing Corporation., 2008*



1.7 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q.No. 1: : A serious disruption in the functioning of community or a society causing widespread material, economic, social or environmental losses which exceed the ability of the affected society to cope using its own resources.

Ans to Q.No. 2: Risk is defined as the expected losses caused by a particular phenomenon. Risk is the function of the probability of particular occurrences and the losses each would cause. It is the probability of a disaster occurring and resulting in a particular level of losses.

Ans to Q.No. 3: Vulnerability is the degree of susceptibility to a hazard, or the lack of capacity to absorb the impact of a hazard and recover from it. It is related not only to physical factors but also to a range of social, economic, cultural and political factors.

Ans to Q.No. 4: Vulnerability assessment (VA) also called vulnerability

analysis is a process that identifies, quantifies and analyzes security weaknesses in IT infrastructure. The primary goal of vulnerability assessment is to unearth any vulnerabilities that can compromise the organization's overall security and operations. As such, the VA can help you minimize the probability of threats.

Ans to Q.No. 5: Risk assessment is a systematic process of evaluating the potential risks that may be involved in a projected activity or undertaking. In other words, risk assessment involves identifying, analyzing, and evaluating risks first in order to best determine the mitigation required.

Ans to Q.No. 6: There may be many reasons a risk assessment is needed, including:

- Before new processes or activities are introduced.
- Before changes are introduced to existing processes or activities, including when products, machinery, tools, equipment change or new information concerning harm becomes available.
- When hazards are identified.



1.8 MODEL QUESTIONS

Q.1: Write short note on India's Key Vulnerabilities.

Q.2: Vulnerability is an essential element for defining disaster impacts and its threat to people. How and in what ways can vulnerability to disasters be characterized?

Q.3: How important is vulnerability and risk assessment for pre-disaster management?

Q.4: Explain the possible risk reduction methods in the event of an earthquake.

*** *** ***

UNIT- 2: CONCEPT OF VULNERABILITY

UNIT STRUCTURE

2.1 Learning Objectives

2.2 Introduction

2.3 Meaning of Vulnerability

2.4 Identification of Vulnerability

2.5 Types and Factors of Vulnerability

2.6 Let us Sum up

2.7 Further Reading

2.8 Answers to Check Your Progress

2.9 Model Questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to-

- describe the meaning of vulnerability
- explain how to identify vulnerability
- recognize various types and factors of vulnerabilities

2.2 INTRODUCTION

In the previous unit you have learnt about the basics of vulnerability and risk. In this unit we are going to discuss the concepts of vulnerability. The elements of hazards vulnerability and identification of vulnerable areas are included in this unit. This unit also covers the factors and typology of vulnerability.

2.3 MEANING OF VULNERABILITY

Vulnerability is the possibility of damage and disruption to a community, structure, service and or geographic area because of a particular hazard on account of their nature, construct and proximity to hazardous terrain or disaster-prone areas.

Different quantitative definitions of vulnerability:

The amount of loss to a given element or set of components at risk resulting from the event of a natural phenomenon of a given magnitude is referred to as its vulnerability. It is measured on a scale from 0 (no damage) to 1 (total loss).

Vulnerability can also be defined as the level of severity up to which a community, a structure, a service, or a geographic area can be affected or distressed by the effect of a certain hazard.

A community's probability of grief in terms of human or material damage when exposed to a hazard is determined by the degree of instability of its elements such as infrastructure, livelihood, manufacturing activities, organizational capacity, early warning or alert systems, and political and institutional development.

Different qualitative definitions of vulnerability:

A community's inability to absorb vulnerability through auto-adjustment is due to the effects of a certain alteration in its environment.

A condition in which human settlements or buildings are in risk due to the vicinity of a hazard, because of the quality of the building materials or both.

The internal risk factor of a subject or exposed system to hazard corresponds to its inherent tendency to be affected or susceptible to suffering a loss.

The predisposition, susceptibility or physical, economic, political or social feasibility of a community to be affected or of grief damages in case a threatening phenomenon of natural or human origin occurs.

Vulnerability describes the characteristics and conditions of a community, system or asset that makes it vulnerable to the damaging effects

of a hazard. There are many facets of vulnerability, arising from various physical, social, economic and environmental factors. For example:

- poor design and erection of buildings,
- insufficient protection of assets,
- lack of public information and alertness,
- limited official appreciation of risks and awareness measures, and
- neglect for prudent environmental management.

Vulnerability varies significantly within a diaspora of the public and over time. This definition identifies vulnerability as distinctive of the element of interest (community, system or asset) which is liberated of its exposure. However, in common use the word is often used more generally to include the exposure of the elements.



CHECK YOUR PROGRESS

Q.1: Define vulnerability with respect to probability of suffering.

.....

Q.2: Define vulnerability with respect to degree of loss.

.....

Q.3: Give one qualitative definition of vulnerability.

.....

2.4 IDENTIFICATION OF VULNERABILITY

Vulnerability to a particular natural hazard or disaster comprises a set of components which help in the identification and determination of nature and types of hazards and disasters. Such vulnerability elements include the following:

1. hazard/disaster such as earthquake, cyclones,volcanic eruptions, floods, droughts, avalanches,landslides, tsunami etc.

2. spatial unit such as a particular locality, a region, a country etc, examples floodplains, coastland, mountain slope, icecaps, islands etc.
3. vulnerable community such as human community, plant community (a forest fire may destroy a large chunk of valuable forest area) and animal community both terrestrial and marine including micro-organisms.
4. speed of hazard such as rapid onset of a natural hazard (e.g., tsunami, earthquake occurrence, lava flow, tornado etc.), slow onset of a natural hazard (e.g., drought, sea level rise etc.)
5. duration of hazard, short- period quick impacts (e.g.tsunami, tornado, seismic events etc.), long-period slow but wide spread impacts (e.g. floods, droughts, sea level rise etc.)
6. resistibility of materials of physical structures such as different types of buildings in varying locations (e.g., hillslopes, floodplains, low coastlands etc.), bridges, roads, rail tracks etc.

There are a variety of vulnerability identifications methods, by which assessments can be conducted and organizations such as the National Oceanic and Atmospheric Administration have developed their own tools to aid this process. The vulnerability assessment considers the potential impact of loss from a disaster as well as the vulnerability of the facility/location due to disaster. Impact of loss is the degree to which the mission of any government is affected from the given threat. A key factor of the vulnerability assessment is properly defining the ratings for impact of loss and vulnerability.

A sample set of definitions for impact of loss is provided below:

Devastating: The facility is irreversibly damaged/contaminated beyond habitable use. Most items/assets are lost, destroyed, or damaged beyond repair/restoration.

Severe: The facility is partially damaged or contaminated. Examples include partial structure breach resulting in weather/water, smoke, impact, or fire damage to some areas. Some items/assets in the facility are damaged

outside repair, but the facility remains mostly intact. The whole facility may be closed for a period of up to two weeks and a portion of the facility may be closed for an extended period of time (more than one month). Some assets may need to be moved to remote locations to protect them from environmental damage. The number of visitors to this and other facilities in the institute may be reduced by up to 50% for a limited period of time.

- **Noticeable:** The facility is temporarily closed or non-operational, but can continue without a break of more than one day. A limited number of assets may be damaged, but the majority of the facility is not affected. The number of visitors to this and other facilities in the organization may be reduced by up to 25% for a limited period of time.
- **Minor:** The facility involves no significant impact on operations (downtime is less than four hours) and there is no loss of major assets.

Vulnerability is defined to be a combination of the attractiveness of a facility as a target and the level of prevention and/or defence provided by the existing countermeasures.

Sample definitions for vulnerability ratings are as follows:

- **Very High:** This is a high-profile facility that provides a very attractive target for potential adversaries, and the level of deterrence and/or defence provided by the existing countermeasures is inadequate.
- **High:** This is a high-profile regional facility or a moderate profile national facility that provides an attractive target and/or the level of deterrence and/or defence provided by the existing countermeasures is inadequate.
- **Moderate:** This is a moderate profile facility that provides a potential target and/or the level of deterrence and/or defence provided by the existing countermeasures is marginally adequate.

Low: This is not a high-profile facility and provides a possible target and/or the level of deterrence and/or defence provided by the existing countermeasures is adequate.

The vulnerability assessment may also include detailed analysis of the potential impact of loss from any hazards.

2.5 TYPES AND FACTORS OF VULNERABILITY

On the basis of elements of hazard/disaster vulnerability, the following vulnerability types may be identified:

- **Individual hazard vulnerability**
  - **Volcanic vulnerability:** Vulnerability to volcanic activities is related to human settlements near the centre of eruption, human population, infrastructure, vegetation, animals etc. The vulnerability is the highest near the centre of eruption and it gradually decreases away from the volcano. If we consider the flow of pyroclastic matter and ash then the vulnerability of people to diseases is no longer less away from the centre of eruption.
  - **Seismic vulnerability:** The vulnerability of earthquakes and their hazardous impacts are determined not on the basis of the magnitude of seismic intensity as determined by richter or mercalli scales but are decided on the basis of quantum of damages done by a specific earthquake to human lives and property. An earthquake becomes vulnerable only when it strikes the populated area.
  - **Tsunami vulnerability:** Tsunamis are high energy waves in the oceans generated by high magnitude earthquakes in the ocean floors or by violent central volcanoc eruptions or by massive undersea landslides.

Tsunamis travel rapidly from their point of origin with low crests across the ocean, often going unnoticed as massive waves silently move. However, they become destructive and increase vulnerability as they pass through the shallow waters of continental shelves, approaching coastal areas. This results in widespread devastation along coastlines, particularly those with low elevations and gentle slopes.

- **Hurricane vulnerability:** Hurricanes are chronic disasters in the gulf coastal and Atlantic coastal areas of the United States of America. The vulnerability of a hurricane increases when it generates a strong surge that races inland, causing widespread inundation under 10 to 15 feet of water and resulting in numerous drownings and the destruction of houses. Additionally, flying planks and timber driven by powerful gale winds cause further deaths and significant damage to human structures.
- **Tornado vulnerability:** Tornadoes are more common in the southern and eastern USA. The arrival of tornadoes is heralded by dark and thick clouds in the sky resulting into complete darkness and minimum visibility and low air pressure. The wind blows with higher velocity which causes cracks in the buildings. Tornadoes though smalllest in area of all the hazardous atmospheric storms but are very vulnerable to human lives and property.
- **Cyclone vulnerability:** The frequency and severity of cyclones have registered increasing trend since 2000 due to global warming. The quantum of damages has also registered increase though number of casualities is decreasing in developed countries as a consequence of better facilities for correct forewarning of impending storms and timely evacuation of people together with better disaster preparedness and mitigation plans. But the vulnerability

increases in the developing and poor countries due to lack of resources for disaster reduction and mitigation plans.

- **Typhoon vulnerability:** Typhoons orginated mainly in North Pacific Ocean mainly in China Sea, eastern and southern coasts of China. It become more vulnerable because of their high wind speed of 180-400 kmh, high tidal surge, high rainfall intensity, very low atmospheric pressures causing unusual rise in sea level. Typhoon cause havoc in the affected areas and thus tremendous loss of human lives and property.
- **Flood vulnerability:** Floods of rivers are the responses of both natural and anthropogenic factors, the causes of floods of the alluvial rivers become highly complex and their relative importance varies from place to place. Occasional heavy rainfall, deforestation, unscientific constructions, earthquake, tsunamis increases vulnerability to riverine areas.
- **Drought vulnerability:** Droughts are more deadly natural environmental hazards because these are directly related to one of the three basic requirements of any form of life that is water and are indirectly related to food and famine because crops and other plants and animals exclusively depends on water. Drought resulting from accumulative effects of water scarcity cause vulnerable and enormous damage to agriculture and natural vegetation and therefore cause famine and starvation of human and animal population of the region concerned.
- **Landslide vulnerability:** Any sort of mass movement of weathered debris leading to landslides, whether on a hillside or valley side slope, depends on the ratio between shearing forces and resisting forces. Increased deforestation, cultivation on cleared hillslopes, construction of roads and reservoirs in the Himalayas have made the mountain ecosystem more fragile and vulnerable to increased frequency and magnitude of different types of landslides.

- **Spatial vulnerability (vulnerable area)**
  - Local area vulnerability (vulnerable locality)
  - Regional vulnerability (vulnerable region)
  - Country vulnerability (vulnerable country)
  - Global vulnerability such as sea level rise etc.
- **Infrastructural vulnerability (vulnerable infrastructure)**
  - Vulnerable water supply system
  - Vulnerable transport system
  - Vulnerable communication system
  - Vulnerable electricity supply system
- **Community vulnerability (vulnerable community)**

If the aforesaid vulnerability types are combined, these may be grouped into the following two categories:

- Physical vulnerability
- Social vulnerability

Community or social vulnerability includes the consideration of a particular community or social group's susceptibility to specific disasters. For example, the fisherman community living near the sea is highly susceptible to adverse effects from atmospheric storms, tidal surges, tsunamis, and similar events. Factors such as the degree of human resistance and adaptation to disasters, the level of social interactions and adjustments to disasters, the psychological response of individuals and society to hazards and their impacts, and the level of community cooperation in rescue and rehabilitation programs all play a role in determining vulnerability.



CHECK YOUR PROGRESS

Q.4: Mention the vulnerability elements.

.....

Q.5: what are different factors of individual hazard vulnerability.

.....

Q.6: What are two important categories of community vulnerability?

.....



2.7 LET US SUM UP

- Vulnerability can be defined as the level of severity up to which a community, a structure, a service, or a geographic area can be affected or distressed by the effect of a certain hazard.

- A community's inability to absorb vulnerability through auto-adjustment is due to the effects of a certain alteration in its environment.

- A key factor of the vulnerability assessment is properly defining the ratings for impact of loss and vulnerability.

- The various types of vulnerability includes Individual hazard vulnerability, Spatial vulnerability, Infrastructural vulnerability, and Community vulnerability.

- The two important categories of community vulnerability are Physical vulnerability and Social vulnerability.



2.7 FURTHER READING

1) "Disaster Mitigation: Experiences and Reflections" by Alka Dhameja and Pardeep Dhameja
2) "Disaster Management: Disaster Management and Mitigation approaches in india" by Paritosh Srivastava
3) "Disaster Mitigation and Management: Post-Tsunami Perspectives" by Jagadish P Gandhi
4) "Disasters: Strengthening Community Mitigation and Preparedness" by Khanna B K
5) "Disaster Education and Management" by Rajendra Kumar Bhandari

6) "Management and Mitigation of Natural Disasters" by Rajan Kumar Sahoo

7) Natural Hazards and Disaster Management: Vulnerability and Mitigation" by R B Singh.

2.8 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No.1. A community's probability of grief, human or material damage if exposed to a hazard according to degree of instability of its elements (infrastructure, livelihood, manufacture activities, organizational degree, early warning or alert systems, political and institutional development etc.)

Ans. to Q. No. 2: The amount of loss to a given element or set of components at risk resulting from the happening of a natural phenomenon of a given magnitude. It is stated on a scale from 0 (no damage) to 1 (total loss).

Ans. to Q. No. 3: The predisposition, susceptibility or physical, economic, political or social feasibility of a community to be affected or of grief damages in case a threatening phenomenon of natural or human origin occurs.

Ans. to Q. No. 4: On the basis of elements of hazard/disaster vulnerability, the following vulnerability types may be identified:

- Individual hazard vulnerability
- Spatial vulnerability (vulnerable area)
- Infrastructural vulnerability (vulnerable infrastructure)
- Community vulnerability (vulnerable community)

Ans. to Q. No. 5: Different factors of Individual hazard vulnerability are:

- Volcanic vulnerability:
- Seismic vulnerability
- Tsunami vulnerability
- Hurricane vulnerability

- Tornado vulnerability
- Cyclone vulnerability
- Typhoon vulnerability
- Flood vulnerability
- Drought vulnerability
- Landslide vulnerability
- El Nino vulnerability etc

Ans. to Q. No. 6: Community vulnerabilities includes two categories:

- Physical vulnerability
- Social vulnerability

2.9 MODEL QUESTIONS

Q.1: Discuss types of vulnerability citing examples.

Q.2: Give a detailed account of various groups which are more vulnerable to disasters.

Q.3: Describe the nature of urban climate and explain the impact of urban climate on global environmental change.



Q.4: How impacts of vulnerabilities vary between individuals and between communities.

Q.5: What is strategic planning for Vulnerability Reduction? Explain.

Q.6: How do urbanization and rural livelihoods influence vulnerability?

UNIT- 3: CONCEPT OF RISK

UNIT STRUCTURE

3.1 Learning Objectives

3.2 Introduction

3.3 Risk Types and Elements

3.4 Relation Among Hazard

3.5 Risk and Reduction of Vulnerability

3.6 Let us Sum up

3.7 Further Reading

3.8 Answers to Check Your Progress

3.9 Model Questions

3.1 LEARNING OBJECTIVES

After reading this unit, you will be able to-

- describe the meaning of risk, their types and elements.
- corelate the relation between risk and hazard
- describe how to reduce hazard, risk and vulnerability

3.2 INTRODUCTION

In the previous unit we have highlighted the concept of vulnerability. In this unit you will be focused on the concept of risk during disaster. The meaning of risk, its types and elements will be discussed in this unit. In addition, the corelation between risk and hazard will be provided in this unit. Lastly, this unit deals with risk and reduction of vulnerability.

3.3 RISK TYPES AND ELEMENTS

Risk is the exposure or the chance of loss due to a particular hazard for a given area and reference period. It may be expressed mathematically as the probability that a hazard impact will occur multiplied by the consequences of that impact. According to the Oxford Dictionary, it is a situation involving exposure to danger or the possibility that something unpleasant or unwelcome will happen. It is, in other words, the chance of something happening that has a negative impact in terms of consequences and likelihood. There are two prospects linked with the incidence of a hazard: first, the risk that a hazard will become an event; and second the risk that the hazard will cause damage.

Risk may be classified into following types:

- **Individual risk:** The risk of fatality or injury to any identifiable individual who live within the zone impacted by landslide or follows a particular pattern of life that might subject him or her to the consequences of the landslide.
- **Societal risk:** The risk of multiple fatalities or injuries to human beings and animals, in society as a whole: one where society would have to carry the burden of landslide causing a number of deaths, injury, financial implications, environmental and other losses.
- **Acceptable risk:** A risk which, for the purpose of life or work, we are prepared to accept as it is, with no regards to its management. Society does not generally consider incurring expenditure on further reducing such risks as justifiable.
- **Tolerable risk:** A risk that society is willing to live with so as to secure certain net benefits with the confidence that it is being properly controlled, kept under review and further reduced as and when possible.

Ansell and Wharton identified 2 basic elements of hazard risks in 1992 and expressed them in the form of the following equation:

Risk = hazard likelihood (L) x hazard consequence (C)

Thus, risk includes the following components:

- Likelihood of the occurrence of the hazards
- Consequences (impacts) of hazards, if occur

In a general sense likelihood means either chance or frequency of an event which may occur in a particular area. Frequency is the number of occurrences of a particular event having hazard potential in a particular area in a specified period of time or say per unit time (per year or per decade or other time span). For example, number of seismic events in an area per decade (10 years) or number of floods occurring in the Brahmaputra plain every year.

On the other hand, hazard probability denotes chance of occurrence of single event in an area. It may be that there is no chance and hence no probability of occurrence of an event or there may be certainty, say 100 percent chance of occurrence. Thus, hazard occurrence probability (P) may be quantified. Several disaster management planners have quantified likelihood or probability of hazard occurrence as follows:

Likelihood (L)	Probability (P) in percentage
Certain	>99
Likely	50 – 98
Possible	5 – 49
Unlikely	2 – 4
Rare	< 2
Extremely rare	0

Hazard consequences generally means impacts of certain events. Thus, consequence of hazard risks is considered in terms of effects of an event on human communities, human establishments including built structures such as residential buildings, office buildings, factories, infrastructure facilities, dams and reservoirs, educational buildings etc., and environment including abiotic and biotic components.

Consequences of an event may be expressed in terms of the following:

- Human causalities
- Injuries to human beings
- Cost of damage calculated/estimated in terms of rupees
- Loss of animals mainly cattle
- Loss of vegetation
- Loss of infrastructural facilities etc.

Hazard consequences impacts can be measured qualitatively and expressed in the following manner:

1. Catastrophic impacts - large number of human causalities, severe injuries to humans, immediate hospitalization and intensive care.
2. Major impacts - moderate causalities and extensive injuries, injured people need hospitalization.
3. Moderate impacts - no human death if needed people with moderate injuries may be hospitalized.
4. Minor impacts - no serious injuries, no human death.
5. Insignificant impacts - no injuries to human, no death.

It may be mentioned that aforesaid 5 qualitative measurement levels have been determined only in terms of human injuries and causalities. Thus, such consequences measurement is not complete because it excludes cost of damages incurred because of a hazard.



CHECK YOUR PROGRESS

Q.1: Define risk.

.....

Q.2: What is societal risk?

.....

Q.3: What are spatial risks?

.....

3.4 RELATION AMONG HAZARD

A disaster happens when a hazard impacts on a vulnerable population and causes damage, causalities and disruption. An earthquake in an uninhabited desert cannot be considered a disaster, no matter how strong the intensity might be.

An earthquake is disastrous when it affects people, infrastructure and activities.

Hazard × vulnerability = disaster

When extent of hazard and vulnerability is low, the resulting disaster will also be of small magnitude.

Hazard × vulnerability = disaster

When extent of hazard is high but vulnerability is low then the disaster will be of small magnitude.

Hazard × vulnerability = disaster

When vulnerability is high but extent of hazard is small then the resulting disaster will also be of small magnitude.

HAZARD × VULNERABILITY = DISASTER

When extent of hazard is very high and the vulnerability is also high then it will result in a huge disaster.

According to common connotation disaster risk is defined as:

(H) hazard x Vulnerability (V)

or

According to engineers and technocrats' disaster risk becomes the product of the following:

(P) probability (of the occurrence of a hazard) x (C) consequences (of a hazard)

Or, P x C

Hazard/disaster risk is viewed in terms of human health and wealth; or it is viewed in terms of environment and nature phenomenon. It may be expressed by the product of H, V and costs C.

$$Rs = H * V * C$$

Where H is the hazard, V is vulnerability and C is cost.

Another two important components of risk are specific risk and total risk.

Specific Risk (Rs): Specific Risk (Rs) is the expected degree of loss due to a particular natural hazard, taking into account the hazard's probability, the vulnerability of the exposed elements, and their exposure level.

Total risk (Rt): The expected number of lives lost, persons injured, damage to property or disruption of economic activity due to an all-natural phenomenon. It is therefore the sum of the specific risks for all return periods and all types of events.

SUM (Rs = H * V * C)

For all elements at risk

For all magnitudes

For all hazard types

Capacity Vulnerability is one side of a coin; the other side representing the resources people have to resist, cope with, or recover from a hazard, or "capacities". Vulnerability is about "not having" while capacities are about "having". Capacity is knowledge, skills, resources, abilities and strength, present in individuals, households and the

communities, which enable them to prevent, prepare for, stand against, survive and recover from a disaster. People's capacities are also highlighted by what are known as "coping strategies". These are responses linked to capacities (or resources) which, in the face of a hazard determine how vulnerable or resilient an individual or household becomes. Some examples of capacity are:

- Permanent houses
- Adequate food and income sources
- Fire stations l Developed health infrastructure
- Good Community Networks for support
- Local knowledge
- Strong community leadership and organizations

Capacity =1/Vulnerability

Risks have always been part of daily life for humans. However, both the level of acceptance and the perception of risk vary from one individual to another. Perception also varies between regions, societies and cultures and therefore, there is no universally valid definition of risk. Risk is the expected damage or loss due to the combination of vulnerability and hazards. People are considered at 'risk' when they are unable to cope with a hazard. A disaster occurs when a significant number of vulnerable people experience a hazard and suffer from severe damage and/or disruption of their livelihood system in such a way that recovery is unlikely without external assistance. Risk is the probability of harmful consequences or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interaction between natural or human-induced hazards and vulnerable conditions (HPC Report, 2001). As far as disaster risk is concerned, it refers to the probability of the occurrence of a disaster. It is a subject to the extent of hazard, vulnerability and capacity. In relation to disasters, Kotze and Holloway (1996) define risk as the expected losses

(lives lost, persons injured, damage to property and disruption of economic activity or livelihood) caused by a particular phenomenon.

Risk is a function of hazard occurrence and the projected losses. A societal element is said to be 'at risk' or vulnerable when it is exposed to hazards and is likely to be adversely affected by the impact of those hazards if and when they occur, especially in situations of limited capacity.

It can be best explained by

Disaster Risk = Hazard × Vulnerability Capacity

The relationship between these four components, indicate that each of the three variables that define risk - the hazard, the elements exposed and their vulnerability - are of equal value. Reducing any one or more of the three contributing variables will lessen the risk to a community. In reality, however, there is little opportunity to reduce the hazard component, therefore, only the vulnerability and the elements at risk will vary. When hazard and vulnerability are high, it will cause disaster but when capacity is present, it will decrease the impact. Hence, to reduce the risk of a disaster,

1) Decrease the vulnerability of the community; and

2) Increase the capacity of the community



CHECK YOUR PROGRESS

Q.4: Give the relationship between hazard, risk, vulnerability and capacity.

.....

Q.5: How capacity is related to vulnerability.

.....

3.5 RISK AND REDUCTION OF VULNERABILITY

The processes and mechanisms of reduction of hazard risk and vulnerability include the following aspects :

1. Hazard analysis
2. Hazard vulnerability analysis
3. Hazard risk analysis

Hazard analysis:

Hazards are those events which have potential to cause the loss of human life and property,social and economic disruption and environmental degradation.

Hazard analysis includes the following aspects:

- Hazard analysis objectives
- Hazard identification
- Hazard classification
- Factors of hazard information
- Causes of hazard occurrence
- Hazard profiles

- Hazard analysis objectives includes analysis of different types of hazards with previous history of occurences and likely occurences in near future in a region or locality.
  - Hazard identifiction includes indentify those hazards whether natural or man-made which are most likely to strike an area or a country and have great potential to inflict heavy loss of human life and property.
  - Hazard classification on the basis of speed of occurrence, hazard duration, on the basis of primary causative factors.
  - A set of factors related to a particular hazards are taken into account to present detailed information which may be helpful in the reduction and management of natural disasters.

- A tentative list of possible causes for the occurrence of potential hazards in a particular area should be prepared for elaborate hazard analysis.
- Hazard profile of an area or region or country concerned must include - hazard name, hazard types, characteristics of potential hazards, frequency of occurences of different types of hazards, recurrence intervals of hazards, hazard duration, speed of on-set of hazards, magnitude of hazards, locations of hazards and spatial extent of hazards.

Hazard vulnerability analysis:

Hazard vulnerability analysis includes the meaning and concepts of vulnerability, elements of hazards vulnerability, vulnerability typology and identification and mapping of vulnerable areas.

Hazard risk analysis includes:

Hazard risk analysis includes the following-

- Assessment of vulnerability of society, a locality, plant and animal communities.
- Assessment of ability of resistance of system to a particular hazard.
- Assessment of ability of resilience of a system affected or to be affected such as humans, plants and animals to recover from the damages done by a particular hazard.
- Risk-cost benefit evaluation
- Assessment of vulnerable localities
- Assessment of vulnerability of different sections of society to a particular hazard.

Hazard risk assessment though a significant aspect of disaster reduction and management is an uphill task because it becomes more or less subjective (in case of voluntary risk assessment) and qualitative as it

becomes difficult and some times impossible to obtain authentic and ample data of risk aspects.

Some parameters are found to determine magnitude and severity of natural hazards such as Richter and Marcali scales to measure the intensity and severity of earthquakes. It is not the magnitude of of a hazard that matters in terms of risk of damage rather it is the vulnerability of the locality and communities to a particular hazard that matters more. Further the building materials also determine the magnitude of risk by earthquakes.

The people living on the hillslope are more vulnerable to seismic events and are liable to maximum risk. Likewise inhabitants of coastal areas in general and fishermen communities in particular have maximum risk of being adversely affected by cyclonic storms, tidal surges and tsunami.

The densely populated flood plains of alluvial rivers are most vulnerable to recurrent severe floods and hence are in maximum risk and threat zone.

Hazards communication is in fact a warning system of probable occurrences of hazards. This is also called risk information which has two basic components as follows:

1) Risk communication system or transmission of hazard and disaster risks information to different segments of society, government and non-governmental organizations.
2) Takers (receivers) of disaster risk information i.e. vulnerable and threatened sections of society.



CHECK YOUR PROGRESS

Q.6: What are the main aspects of reduction of hazard risk and vulnerability?

.....

Q.7: What are two basic components of risk information?

.....



3.6 LET US SUM UP

- The effects and responses of hazards and disaster risk warnings depend on the types of media through which risk assessment are communicated, sources of risk information, credibility and acceptability of risk information, nature of responses and adaptability to risk information from different segments of society etc.
- The perception of hazard risks and disaster threats varies from person to person and from community to community.
- Management of hazard is essential for reducing the losses.
- A hazard and vulnerability analysis helps in identifying specific areas of risk and vulnerability.
- Two important components of risk are specific risk and total risk.
- Hazard analysis includes Hazard analysis objectives, Hazard identification, Hazard classification, Factors of hazard information, Causes of hazard occurrence and Hazard profiles.



3.7 FURTHER READING

1. Ayaz, Disaster Management: *Through the New Millennium*. Anmol Publications. (2009)
2. Dave, P. K. *Emergency Medical Services and Disaster Management: A Holistic Approach.* New Delhi: Jaypee Brothers Medical Publishers (P) Ltd., 2009
3. Narayan, B. *Disaster Management*, New Delhi: A.P.H. Publishing Corporation ,2009
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3.8 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q.No.1: Risk is the exposure or the chance of loss due to a particular hazard for a given area and reference period. It may be expressed mathematically as the probability that a hazard impact will occur multiplied by the consequences of that impact.

Ans. to Q.No.2: The risk of multiple fatalities or injuries in society as a whole: one where society would have to carry the burden of landslide causing a number of deaths, injury, financial, environmental and other losses.

Ans. to Q.No.3: Spatial Risk Scores measures and quantifies hundreds of location-specific factors that can have a long-term effect on asset value, environmental impact, operational effectiveness, and social sustainability.

Ans. to Q.No.4: Hazard or disaster risk is viewed in terms of human health and wealth. It is also viewed in terms of environment and nature phenomenon.

It may be expressed by the product of H, V and costs C.

$$Rs = H * V * C$$

Where H is the hazard, V is vulnerability and C is costs.

Ans. to Q.No.5: Capacity expresses the positive managerial and operational resources and procedures for reducing hazard and risk factors.

Ans. to Q.No.6: The main aspects of reduction of hazard risk and vulnerability are:

1. Hazard analysis

2. Hazard vulnerability analysis
3. Hazard risk analysis

Ans. to Q.No.7: The two basic components of risk information are as follows:

i. Risk communication system or transmission of hazard and disaster risks information to different segments of society, government and non-governmental organizations.

ii. Takers (receivers) of disaster risk information i.e. vulnerable and threatened sections of society.



3.9 MODEL QUESTIONS

Q.1: Discuss the concept Risk Assessment.

Q.2: At what point can a hazard risk be considered "safe"?

Q.3: Define the term mainstreaming Risk.

Q.4: Write about steps for mapping Risk Assessment.

Q.5: Why do individuals and societies choose to expose themselves to a hazard risk when selecting a place to live or to form a settlement.

Q.6: Write about the initiatives taken for Risk Reduction in India.

Q.7: Discuss about participatory risk assessment methods.

Q.8: How is climate change impacting community risk?

Q.9: Write the role of science & technology in Disaster Risk Reduction and Management.

*** *** ***

UNIT- 4: PRELIMINARIES OF VULNERABILITY AND RISK ASSESSMENT

UNIT STRUCTURE

4.1 Learning Objectives

4.2 Introduction

4.3 Understanding Vulnerability and Risk assessment

4.4 Vulnerability Analysis

4.5 Risk Analysis

4.6 Risk Mapping

4.7 Let us Sum up

4.8 Further Readings

4.9 Answers to Check Your Progress

4.10 Model Questions

4.1 LEARNING OBJECTIVES

After going through this unit, you will be able to-

- discuss the meaning of vulnerability and risk assessment.
- explain the techniques on how to conduct vulnerability and risk assessment.

4.2 INTRODUCTION

In the previous unit you have learnt the concept of risk and its relation with hazards. In this unit we are going to discuss the analysis of assessment of vulnerability and risks. Vulnerability and risk assessment are crucial components of disaster management. In this unit you will be familiarized with the importance of vulnerability and risk assessment. This unit also

involves the analysis of vulnerability and their associated risks. Risk mapping will also be explored and focussed at the end of this unit.

4.3 UNDERSTANDING VULNERABILITY AND RISK ASSESSMENT

Vulnerability refers to the susceptibility of communities, organizations, and systems to the potential impacts of disasters. Thus, vulnerability assessment refers to the process of identifying, quantifying and prioritizing or ranking the vulnerabilities within a system. From the viewpoint of disaster management, vulnerability assessment is assessing the threats from potential hazards to the population and to the infrastructure.

Vulnerability focuses on the awareness of people, properties and resources due to the impact associated with the hazards such as earthquakes, hurricanes, floods etc. The United Nations Disaster Management Training Programme (1994) defined vulnerability as the "degree of loss to a given element at risk (or set of elements) resulting from a given hazard and a given severity level". The approach to vulnerability can be appraised at various levels and from differing aspects. The United Nations for Disaster Risk Reduction (UNDRR) is the United Nations' focal point for reduction in disaster risk. This organization supports the different countries in its implementation, monitoring and sharing what works in reducing risk and preventing the creation of new risk.

Vulnerability assessment and risk assessment are two important tools used in disaster management to identify potential hazards and vulnerabilities and to evaluate the likelihood and severity of their impacts. Vulnerability assessment involves identifying and analysing the potential vulnerabilities of people, infrastructure, and the environment to hazards such as floods, earthquakes, storms and other natural or man-made disasters. The aim of vulnerability assessment is to identify and prioritize the most vulnerable populations and areas, as well as to evaluate the existing capacity to cope with disasters.

Risk assessment, on the other hand, involves evaluating the likelihood and potential impacts of potential hazards on people, infrastructure, and the environment. Risk assessment takes into account the potential consequences of a disaster, as well as the likelihood of the occurrence of the disaster. The aim of risk assessment is to identify the most significant risks and to develop strategies to mitigate those risks, such as through prevention, preparedness, response and recovery measures.

Thus, vulnerability assessment and risk assessment provide a comprehensive understanding of the potential hazards and vulnerabilities faced by a community or region and the likelihood and severity of their impacts. This understanding can help disaster management teams to prioritize resources, develop strategies for disaster prevention, preparedness, response and recovery and ultimately reduce the risk and impact of disasters.

Vulnerability assessment and risk assessment are two different processes those are often used in disaster management, although they are related to each other. The differences between the two can be summarized as follows:

Definition:

Vulnerability assessment is the process of identifying and evaluating the susceptibility of people, infrastructure, and the environment to potential hazards.

Risk assessment, on the other hand is the process of identifying, evaluating and prioritizing the potential impact of hazards on people, infrastructure, and the environment.

Focus:

Vulnerability assessment focuses on identifying the potential weaknesses and limitations of assets and systems that may be impacted by hazards. Risk assessment, on the other hand focuses on evaluating the potential consequences of hazards and the likelihood of their occurrence.

Outcome:

The outcome of a vulnerability assessment is an understanding of the potential impact of hazards on assets and systems. The outcome of a risk assessment is an understanding of the likelihood of hazards occurring,

the potential consequences of those hazards and the level of risk associated with those consequences.

Use:

Vulnerability assessment is often used to identify areas that need improvement or intervention to reduce the potential impact of hazards. Risk assessment is often used to prioritize risks and allocate resources to mitigate the potential consequences of hazards.

Overall, vulnerability assessment and risk assessment are complementary processes that can be used together to better understand the potential impact of hazards and reduce the risk of disasters. Vulnerability assessment focuses on identifying weaknesses and limitations in assets and systems, while risk assessment focuses on evaluating the potential consequences of hazards and likelihood of their occurrence.



CHECK YOUR PROGRESS

Q.1: What is vulnerability?

.....

Q.2: What do you mean by vulnerability assessment?

.....

Q.3: What is risk assessment?

.....

4.4 VULNERABILITY ANALYSIS

In vulnerability analysis, key concepts like sensitivity, resilience and adaptive capacity are relevant for understanding and assessing the vulnerabilities of systems, communities, or elements at risk. Sensitivity refers to the degree to which a system's physical, social or ecological characteristics make it susceptible to the impacts of a hazard. Sensitivity analysis assesses how changes in hazard intensity or exposure can affect

the system or element's vulnerability. Factors such as infrastructure quality, population density, ecological fragility, or socioeconomic conditions influence the sensitivity of a system to hazards.

Resilience represents the capacity of a system or community to absorb shocks, adapt, and recover from a hazardous event. It focuses on the system's ability to bounce back, restore functionality, and return to a desirable state after a disruption. Resilience analysis considers the inherent strengths, resources, and adaptive capacities of the system. Factors such as preparedness measures, social cohesion, economic diversity, governance structures, and infrastructure robustness contribute to the resilience of a system.

Adaptive capacity refers to the ability of a system or community to adjust and respond to changing conditions, including hazards and their associated impacts. It assesses the system's capacity to learn, innovate, and implement measures to reduce vulnerability and enhance resilience. Adaptive capacity analysis considers factors such as access to information, knowledge, technology, financial resources, governance mechanisms, and social networks that enable proactive adjustments and adaptive responses to hazards.

To identify and evaluate exposure, sensitivity and adaptive capacity of elements at risk, the following steps can be followed:

1. **Identify Elements at Risk:** Determine the specific elements or assets that are vulnerable to hazards. This could include physical infrastructure, critical facilities, population groups, or ecological systems. The boundaries and characteristics of each element at risk should be clearly defined.
2. **Exposure Assessment:**

   Hazard Mapping: Identify and map the hazards that pose a risk to the elements at risk. This involves analyzing historical data, expected knowledge, hazard maps, and other relevant sources.

   Physical Proximity: Assess the physical proximity of the elements at risk to the hazards. Determine their geographical location, elevation, and distance from potential sources of hazards.

Hazard Intensity: Evaluate the potential intensity or magnitude of the hazards and their potential impacts on the elements at risk. Factors such as frequency, severity, and duration of the hazards needs to be considered.

3. **Sensitivity Analysis:**

Physical Sensitivity: Assess the physical vulnerability of the elements at risk. The structural integrity, age, design standards, maintenance and quality are to be considered.

Social Sensitivity: Evaluate the social characteristics and vulnerabilities of the elements at risk. Considerable factors such as population density, poverty levels, accessibility to essential services, and the presence of vulnerable groups.

Ecological Sensitivity: Analyze the ecological sensitivity of natural and environmental elements at risk. Considerable factors are biodiversity, habitat quality, ecosystem services and ecological connectivity.

4. **Adaptive Capacity Assessment:**

Socio-economic Factors: Evaluate the socioeconomic characteristics and resources available to the elements at risk. Considerable factors such as governance, institutions, policies, economic conditions, and social networks.

Infrastructure and Technology: Assess the availability and quality of infrastructure, utilities, and technology that can enhance the adaptive capacity of the elements at risk. Considerable factors such as transportation networks, communication systems, and access to early warning systems.

Human and Social Resources: Evaluate the skills, knowledge, and capacities of individuals and communities to respond to and recover from hazards. Considerable factors such as education, training, local organizations, and community networks.

Institutional Capacity: Assess the capacity of local institutions, including government agencies, emergency services, and community-based organizations, to effectively respond to hazards and support recovery efforts.

5. **Data Collection and Analysis:** Collect relevant data and information to support the assessment of exposure, sensitivity, and adaptive capacity. This can include existing reports, statistical data, maps, surveys, interviews, and expert knowledge. This can include existing reports, statistical data, maps, surveys, interviews, and expert techniques, considering both qualitative and quantitative approaches.
6. **Integration and Evaluation:** Integrate the findings from the exposure, sensitivity and adaptive capacity assessments to evaluate the overall vulnerability of the elements at risk. Identify the area or elements that are most exposed, sensitive, or have low adaptive capacity. Consider the interactions and interdependencies between exposure, sensitivity, and adaptive capacity factors.
7. **Documentation and Reporting:** Document the results of the assessment, including the data sources used, methodologies applied, and any limitations or uncertainties. Present the findings in a clear and concise manner that can be easily communicated to stakeholders. Use maps, charts and graphs to visually represent the vulnerabilities identified.

The process of vulnerability analysis involves several steps to assess and understand the vulnerabilities of communities, systems, or infrastructure to various hazards.

1. **Define the Scope:** Clearly define the scope and objectives of the vulnerability analysis. Identify the area, community, or system to be assessed and specify the hazards of concern.
2. **Hazard Identification:** Identify and document the hazards that could affect the area or community. This includes natural hazards (eg., floods, earthquakes, hurricanes) and human-induced hazards (e.g., industrial accidents, conflicts).
3. **Data Collection:** Gather relevant data and information to support the vulnerability analysis. This includes existing reports, maps, statistical data, and expert knowledge. Data can be collected through surveys, interviews, focus group discussions, and site visits.

4. **Exposure Assessment:** Evaluate the exposure of the area, community, or assets to the identified hazards. Assess the physical proximity and susceptibility of the elements at risk to the hazards. Assess the physical proximity and susceptibility of the elements at risk to the hazards. Considerable factors such as location, elevation, proximity to water bodies, and infrastructure.
5. **Sensitivity Analysis:** Analyze the sensitivity of the exposed elements to the impacts of hazards. Evaluate their susceptibility and fragility to damage or disruption. Consider social, economic, and environmental factors such as population density, poverty levels, critical infrastructure, and ecological systems.
6. **Adaptive Capacity Assessment:** Assess the adaptive capacity of the area or community to cope with and recover from hazards. Evaluate the existing resources, capacities, and capabilities to respond, adapt, and bounce back. Consider factors such as governance, institutions, social networks, infrastructure, technology, and access to information and resources.
7. **Data Analysis and Modelling:** Analyze the collected data using appropriate analytical methods and modelling techniques. Quantitative and qualitative data can be analyzed to identify patterns, trends, and relationships. Use statistical methods, geographic information systems (GIS), or other modelling tools to support the analysis.
8. **Vulnerability Mapping:** Spatially represent the vulnerabilities identified in the analysis. Use GIS or other mapping techniques to overlay hazard information with exposure, sensitivity and adaptive capacity data. Create maps that visually depict the areas or populations most vulnerable to specific hazards.
9. **Stakeholder Engagement:** Involve relevant stakeholders throughout the vulnerability analysis process. Engage with community members, local authorities, experts, and organizations to gather their insights, knowledge, and perspectives. Their input is valuable for a comprehensive understanding of vulnerabilities.

10. **Reporting and Communication:** Document the findings of the vulnerability analysis in a clear and accessible report. Present the results in a format that is understandable to various stakeholders. Communicate the vulnerabilities effectively to decision makers, policymakers, and practitioners involved in disaster management.
11. **Risk Assessment and Prioritization:** Combine the vulnerability analysis with hazard assessment to conduct a comprehensive risk assessment. Evaluate the likelihood and potential impact of hazards on the vulnerable elements. Prioritize the risks based on their severity and probability to guide decision-making and resource allocation.
12. **Action Planning and Implementation:** Develop strategies, policies and plans to address the identified vulnerabilities. Implement risk reduction measures, emergency preparedness initiatives, and resilience-building activities. Ensure active participation and collaboration among stakeholders to implement the recommended actions effectively.
13. **Monitoring and Evaluation:** Continuously monitor and evaluate the effectiveness of the implemented measures and interventions. Update the vulnerability analysis regularly to account for changes in the environment, community dynamics, or knowledge. Adjust strategies and actions as needed to enhance resilience.

When conducting a vulnerability analysis, it is important to consider both tangible and intangible vulnerable elements. These elements encompass a wide range of factors that contribute to the vulnerability of a community or system. Here's an explanation of tangible and intangible vulnerable elements:

1. **Tangible vulnerable elements:** Tangible Vulnerable Elements refer to physical, observable and measurable aspects that are susceptible to damage or disruption during a hazard event. These include:
    - Infrastructure: Physical structures, such as buildings, bridges, roads, dams, and utilities, that may be at risk of damage or collapse.
    - Critical Facilities: Essential facilities like hospitals, schools, emergency response centers and communication networks,

which, if affected, can severely impact the community's ability to respond and recover.

- Housing: Residential buildings and shelters that may be poorly constructed, located in hazard-prone areas, or lack necessary safety features.
- Lifelines: Systems and networks that provide vital services, such as water supply, electricity, transportation, and communication, which, if disrupted, can hinder response and recovery efforts.
- Natural Resources: Environmental elements, including forests, wetlands, and coastal areas, that provide ecosystem services and contribute to community resilience but are susceptible to degradation or depletion.

2. **Intangible vulnerable elements:** Intangible vulnerable elements refer to social, economic, and institutional aspects that may not have a physical presence but have significant influence on the vulnerability of a community. These include:
   - Socio-economic Factors: Social characteristics, such as poverty, inequality, marginalized groups, and lack of access to education, healthcare, and social services, which can magnify vulnerability and limit coping capacities.
   - Social networks and community cohesion: The strength of social connections, cooperation, and mutual support within a community that can enhance resilience and the ability to recover from disasters.
   - Governance and Institutions: The effectiveness of governance structures, policies, regulations, and institutions responsible for disaster management, planning, and response. Weak governance can hinder preparedness and response efforts.
   - Knowledge and Awareness: The level of awareness, understanding and knowledge about hazards, risks, and appropriate response measures within the community.

- Cultural and Historical Context: Cultural beliefs, practices, and historical experiences that influence perceptions, behaviour, and decision-making related to hazards and disasters.

Table 4.1: Tangible and Intangible Vulnerable Elements

PRINCIPAL VULNERABLE ELEMENTS		
	Tangible	Intangible
Floods	Everything located in flood plains or tsunami areas. Crops, livestock, machinery, equipment, infrastructure Weak buildings.	Social cohesion, community structures cohesion, cultural artifacts.
Earthquakes	Weak buildings and occupants. Machinery and their equipment, infrastructure. Livestock. Contents of weak buildings.	Social cohesion, community structures cohesion, cultural artifacts.
Landslides	Anything located on or at base of steep slopes or cliff tops, roads and infrastructure, buildings on shallow foundations.	Social cohesion, community structures cohesion, cultural artifacts.
Strong winds	Lightweight buildings and roofs. Fences, trees, signs; fishing boats and coastal industries, Crops and livestock.	Community structures, social cohesion, cultural artifacts.
Technological disasters	Lives and health of those involved or near the vicinity. Building, equipment, infrastructure, crops and livestock.	Destruction of the environment. Cultural losses. Possible population disruption.

(Adapted from Primer on Natural Hazard Management, OFDA, 1991)



CHECK YOUR PROGRESS

Q.4: What is sensitivity in vulnerability analysis?

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Q.5: What do you mean by resilience in vulnerability analysis?

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Q.6: What is adaptive capacity in vulnerability analysis?

.....

Q.7: What are the tangible and intangible elements in floods and earthquakes?

.....

4.5 RISK ASSESSMENT

The methodology of risk assessment may vary depending on the specific context, sector, and objectives of the assessment. However, here is a general framework for conducting a risk assessment:

1. **Establish the Scope and Context:**
   - Clearly define the purpose and objectives of the risk assessment.
   - Identify the system, area, or assets under assessment.
   - Determine the time frame and geographical boundaries of the assessment.
   - Consider any relevant regulations, standards, or guidelines applicable to the assessment.
2. **Identify Hazards:**
   - Identify and list the potential hazards that could affect the system or area.

- Consider natural hazards (e.g., earthquakes, floods, storms), technological hazards (e.g., chemical spills, power outages), or other relevant hazards.
- Gather available data, historical records, scientific studies, expert opinions, and hazard maps/models to support hazard identification.

3. Assess probability:

- Evaluate the likelihood or probability of each identified hazard occurring within the defined time frame.
- Use available data, historical records, statistical analysis, expert judgment, or probabilistic models to estimate the probability.
- Consider factors such as frequency, historical occurrence, climate change projections, or other relevant factors.

4. Determine Consequences:

- Identify the potential consequences or impacts of each hazard on the system or assets at risk.
- Consider direct impacts (e.g., damage to infrastructure, loss of life), indirect impacts (e.g., economic losses, environment impacts), and cascading effects.
- Use available data, impact models, scenario analysis, or expert judgment to estimate the consequences.

5. Estimate Risk:

- Combine the information on hazard probability and consequences with vulnerability analysis to estimate the level of risk.
- Use qualitative, semi-qualitative, or quantitative methods to assess the risk level.
- Consider risk matrices, risk scoring systems, or other risk assessment tools to quantify and prioritize risks.

6. Mitigation and decision-making:

- Based on the risk assessment results, identify and prioritize risk mitigation measures.

- Develop risk management strategies and action plans to reduce or control the identified risks.
- Consider cost-benefit analysis, feasibility, and stakeholder input in decision-making processes.

7. Communication and Documentation:

- Clearly communicate the risk assessment findings to relevant stakeholders, decision-makers, and the public.
- Use appropriate formats, such as reports, visualizations, or presentations, to convey the results effectively.
- Document the risk assessment methodology, data sources, assumptions, and limitations for transparency and future reference.

4.6 RISK MAPPING

Risk mapping, also known as hazard mapping or vulnerability mapping, is a process of visually representing and spatially analyzing risks associated with hazards in a particular area. It involves the identification, assessment, and visualization of risks to support decision-making and planning for disaster management. Some of the key steps involved in risk mapping:

- **Data Collection:** Gather relevant data on hazards, vulnerability factors, and elements at risk in the target area. This may include information on historical events, hazard maps, infrastructure, population distribution, socio-economic indicators, and environmental data.
- **Hazard Assessment:** Identify and assess the hazards that pose a risk to the area. This can involve analyzing historical data, conducting hazard modelling, and considering expert opinions. Hazard maps can be created to depict the spatial extent and intensity of hazards.

- **Vulnerability assessment:** Analyze the vulnerability of the elements at risk in the area. This includes evaluating their exposure, sensitivity, and adaptive capacity, as discussed earlier. Data on population demographics, socio-economic status, infrastructure conditions, and environmental factors may be used to assess vulnerability.
- **Spatial Analysis:** Utilize Geographic Information System (GIS) tools to integrate and analyze the spatial data. This involves mapping hazard zones, vulnerability hotspots, and risk levels. GIS software allows for spatial overlay analysis, which helps identify areas of high risk and areas where interventions are most needed.
- **Visualization and Communication:** Present the risk mapping results in a clear and accessible manner. This can involve creating maps, charts, or other visual representations to effectively communicate the spatial distribution of risks. It is essential to use understandable and visually appealing formats to facilitate decision-making and public understanding.
- **Update and Iterative Process:** Risk mapping is an iterative process that should be updated regularly. As new data becomes available or the risk profile changes, the risk maps should be revised and updated to reflect the most current information. Regular updates help ensure the accuracy and relevance of the risk mapping process.

In risk mapping, F-N curves (Frequency-Number Curves) are commonly used to represent the relationship between the frequency of an event and the number of elements at risk affected by that event. F-N curves are useful for understanding the distribution of risk levels across different thresholds or levels of impact. Here's how F-N curves are typically constructed in risk mapping:

- **Identify events:** Determine the range of events or hazards to be analyzed. This can include events of different magnitudes or intensity levels such as floods of varying return periods or earthquakes of different magnitudes.

- **Define Impact Levels:** Determine the impact levels or thresholds of interest. These can be defined based on specific criteria, such as damage to infrastructure, loss of life, economic losses, or other relevant factors.
- **Quantity Impacted Elements:** Assess the number of elements at risk (e.g., buildings, population, critical infrastructure) that are affected at each event magnitude or intensity level. This can be based on historical data, modeling, or expert judgment.
- **Calculate Frequencies:** Calculate the frequency or probability of each event occurring within a specific time frame. This can be based on historical records, statistical analysis, or probabilistic modeling.

The F-N curve can be plotted by representing the frequency of events on the X-axis and the number of Impacted Elements on the Y-axis. Each point on the curve represents a specific impact level.

Interpretation of the curve: The F-N curve is analyzed to understand the risk distribution. The shape of the curve indicates how the number of impacted elements varies with different event frequencies. Steeper slopes indicate higher vulnerability or sensitivity to events, while flatter slopes indicate lower vulnerability.

Risk mapping provides valuable insights for decision-makers, emergency managers, and communities by visualizing the spatial patterns of risks and enabling targeted interventions and planning. It helps identify high-risk areas, prioritize resources, and guide policy development for disaster risk reduction and resilience-building efforts.



CHECK YOUR PROGRESS

Q.8: What is Risk Mapping?

.....

Q.9: What is Frequency- Number curve?

.....



4.7 LET US SUM UP

- Vulnerability and risk assessments are crucial steps in disaster management, as they help to identify and prioritize potential hazards and their potential impact on a community or region.
- A vulnerability assessment involves identifying the potential weakness or limitations in a system or community that could be exploited by a disaster.
- In vulnerability analysis, the concepts are interrelated and intertwined.
- Sensitivity analysis identifies the elements or systems that are most prone to the impacts of hazards.
- Resilience analysis examines the system's capacity to withstand, absorb, and recover from these impacts.
- Adaptive capacity analysis explores the system's ability to adapt and implement measures to reduce vulnerabilities and enhance resilience over time.
- Understanding both tangible and intangible vulnerable elements is crucial for a comprehensive vulnerability analysis.
- Risk mapping provides valuable insights for decision-makers, emergency managers, and communities by visualizing the spatial patterns of risks and enabling targeted interventions and planning.
- The F-N curve provides a visual representation of the cumulative risk profile across different levels of impact and event frequencies.
- Overall, vulnerability and risk assessments are essential components of effective disaster management.



4.8 FURTHER READING

1) Coburn, A.W., Spence, R.J., and Pomonis A. (1991). Vulnerability and risk assessment. In Vulnerability and risk assessment.

2) Dewan, A., and Dewan, A.M. (2013). Vulnerability and risk assessment. Floods in a Megacity: Geospatial Techniques in assessing Hazards, Risk and vulnerability.

4.9 ANSWERS TO CHECK YOUR PROGRESS

Q. No. 1: Vulnerability refers to the awareness of people, properties and resources due to the impact associated with the hazards such as earthquakes, hurricanes, floods etc. The United Nations Disaster Management Training Programme (1994) defined vulnerability as the "degree of loss to a given element at risk (or set of elements) resulting from a given hazard and a given severity level".

Q. No. 2: Vulnerability assessment involves identifying and analyzing the potential vulnerabilities of people, infrastructure, and the environment to hazards such as floods, earthquakes, storms and other natural or man-made disasters.

Q. No. 3: Risk assessment involves evaluating the likelihood and potential impacts of potential hazards on people, infrastructure, and the environment. Risk assessment takes into account the potential consequences of a disaster, as well as the likelihood of the disaster occurring.

Q. No. 4: Sensitivity refers to the degree to which a system's physical, social or ecological characteristics make it susceptible to the impacts of a hazard. Sensitivity analysis assesses how changes in hazard intensity or exposure can affect the system or element's vulnerability.

Q. No. 5: Resilience represents the capacity of a system or community to absorb shocks, adapt, and recover from a hazardous event. It focuses on

the system's ability to bounce back, restore functionality, and return to a desirable state after a disruption.

Q. No. 6: Adaptive capacity refers to the ability of a system or community to adjust and respond to changing conditions, including hazards and their associated impacts. It assesses the system's capacity to learn, innovate, and implement measures to reduce vulnerability and enhance resilience.

Q. No. 7: Tangible elements of Floods are - Everything located in flood plains or tsunami areas which may be crops, livestock, machinery, equipment, infrastructure, weak buildings. Intangible elements of floods are- Social cohesion, community structures cohesion, cultural artifacts.

Tangible elements of earthquakes are- Weak buildings and occupants, machinery and their equipment, infrastructure, livestock, contents of weak buildings. Intangible elements of earthquake are- Social cohesion, community structures cohesion, cultural artifacts.

Q. No. 8: Risk mapping, also known as hazard mapping or vulnerability mapping, is a process of visually representing and spatially analyzing risks associated with hazards in a particular area. It involves the identification, assessment, and visualization of risks to support decision-making and planning for disaster management.

Q. No. 9: F-N curves (Frequency-Number Curves) are commonly used to represent the relationship between the frequency of an event and the number of elements at risk affected by that event. F-N curves are useful for understanding the distribution of risk levels across different thresholds or levels of impact.



4.10 MODEL QUESTIONS

Q.1: What is the difference between vulnerability and risk assessment in terms of disaster management?

Q.2. How do you identify and evaluate exposure, sensitivity and adaptive capacity of elements at risk?

Q3. Explain the tangible and non-tangible elements with reference to Principal vulnerable elements.

Q.4. Explain the frequency-number curve used in risk mapping?

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UNIT- 5: DEVELOPMENT AND VULNERABILITY

UNIT STRUCTURE

5.1 Learning Objectives

5.2 Introduction

5.3 Disaster Related Vulnerability

5.4 Sustainable Development for Vulnerability Reduction

5.5 Let us Sum up

5.6 Further Readings

5.7 Answers to Check Your Progress

5.8 Model Questions

5.1 LEARNING OBJECTIVES

After going through this unit, you will be able to-

- recognize the relationship between development and vulnerability.
- develop some idea about disaster related vulnerability and sustainable development for vulnerability reduction.

5.2 INTRODUCTION

In the previous unit we have discussed regarding preliminaries of vulnerability and risk assessment. In this unit you will be exposed to development and vulnerability. In this unit, we will explore the concepts of development and vulnerability. Development and vulnerability to disasters are interconnected; the level of development in a region or country impacts its vulnerability to disasters and its ability to cope with and recover from

them. This unit will focus on disaster-related vulnerability and how sustainable development can lead to vulnerability reduction.

5.3 DISASTER RELATED VULNERABILITY

Disaster reduction and surviving with disasters embrace many regions of human life and society comprising a core task for sustainable development. Some major UN Conferences on Environment and Development (Rio de Janerio, 1992) and Reduction of Natural disasters (Yokohama, 1994) have pointed out that natural disasters cannot be attributed to natural causes; they are as much a result of incorrect human conduct. In the past few years, it has been observed that there has been an apparent increase in the number of natural disasters, and along with it, increasing losses on account of urbanisation and population growth. Thus, the perspective on development has been one-dimensional, that is, cognisance has been taken exclusively of the growth aspect, without an eye on sustainability. As a result, the impact of natural disasters is now felt to a greater extent.

Development and vulnerability to disasters are two closely linked concepts and have been examined by many scholars and practitioners and have concluded that a new strategy is needed to address both issues in a concurrent and comprehensive manner. Mileti et al., 1995 observed that "losses from natural disasters occur because of development that is unsustainable." Development refers to the process of economic, social, and political progress that improves the well-being of individuals and communities. Vulnerability, on the other hand refers to the susceptibility of individuals and communities to the negative impacts of disasters.

The relationship between development and vulnerability is complex. While development can improve the resilience of communities to disasters, it can also increase their vulnerability. For example, rapid urbanization and the growth of informal settlements can increase the vulnerability of communities to disasters such as floods or landslides. Similarly, economic

development can lead to the expansion of sectors those are susceptible to natural hazards, such as agriculture, industries or tourism (services).

Conversely, disasters can also have a negative impact on development. Disasters can cause significant damage to infrastructure and property, disrupt economic activity and lead to the displacement of people. These impacts can have long-term consequences for the economic, social, and political development of affected communities. Effective disaster management requires an understanding of the relationship between development and vulnerability. By taking a comprehensive approach to disaster management that considers the social, economic and political factors that contribute to vulnerability, communities can reduce their susceptibility to disasters and improve their overall resilience. This can include measures such as developing early warning systems, improving infrastructure, and strengthening social safety nets to support vulnerable populations. Overall, the goal of disaster management in the context of development and vulnerability is to build more resilient communities that are better equipped to withstand, and recover from, disasters.

Disaster-related vulnerability refers to the degree to which individuals, communities, or systems are susceptible to harm or negative impacts caused by natural or human-made disasters. Vulnerability can arise from a range of factors, including poverty, inadequate infrastructure, lack of access to resources, environmental degradation and social and economic inequality. Disaster can exacerbate pre-existing vulnerabilities and inequalities, leading to disproportionate impacts on already marginalized groups. For example, individuals living in poverty may be more vulnerable to the effects of a natural disaster because they may lack access to safe housing, healthcare and other basic necessities.

In the context of disasters, vulnerability can manifest in many ways as follows:

1. **Physical vulnerability:** The susceptibility of buildings, infrastructure, and other physical assets to damage or destruction because of disasters such as earthquakes, floods, storms, or wildfires.

2. **Social vulnerability:** The susceptibility of people and communities to the impacts of disasters, including impacts on health, safety, livelihoods, and social networks. Social vulnerability can be influenced by factors such as age, gender, ethnicity, income and education.
3. **Economic vulnerability:** The susceptibility of individuals, communities and economies to the impacts of disasters, including impacts on income, employment and economic growth.
4. **Environmental vulnerability:** The susceptibility of ecosystems and natural resources to the impacts of disasters, including impacts on biodiversity, water resources, and soil fertility.

Understanding and addressing disaster- related vulnerability is essential for disaster preparedness, response, and recovery efforts. This involves identifying vulnerable populations, improving infrastructure and access to resources, promoting social and economic quality and implementing measures to mitigate the impact of disasters on communities and individuals.

Thus, to clarify the ways in which disasters and development interact, it is necessary to distinguish between economic and social elements of development. These social and economic development work directly or indirectly to decrease or increase disaster risk. The table below (Table no. 5.1) outlines the relation between social and economic development with disasters.

Table 5.1: Relationship between social and economic development with disasters.

Disaster Development		
	Social development	Economic development
Disaster limits development	Destruction of fixed assets. Damage to transport, communication, infrastructure. Erosion of livelihood.	Destruction of health or education infrastructure and personnel. Death, migration of key social actors leading to an erosion of social capital.

Development causes disaster risk	Unstable development practices that create wealth for some at the expense of unsafe working or living conditions for others or degrade the environment.	Development path generating cultural norms that promote social isolation or political exclusion.
Development reduces disaster risk	Access to adequate drinking water, food, waste management and a secure dwelling increases people's resilience. Trade and technology can reduce poverty. Investing in financial mechanisms and social security can cushion against vulnerability.	Building community cohesion, recognising excluded individuals or social groups, and providing opportunities for greater involvement in decision-making, enhanced educational and health capacity increases resilience.



CHECK YOUR PROGRESS

Q.1: : What is the relationship between development and vulnerability?

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Q.2: What is disaster- related vulnerability?

.....

5.4 SUSTAINABLE DEVELOPMENT FOR VULNERABILITY REDUCTION

Disaster risk reduction (DRR) is an integral part of social and economic development, and is essential if development is to be sustainable for the future. This have been recognized by several global documents on DRR and sustainable development. The Yokohama strategy and Plan of Action for a safer world (1994) was the first major international framework for disaster risk reduction, and recognized the interrelation between sustainable development and DRR.

Vulnerability reduction refers to the process of reducing the susceptibility of individuals, communities, and societies to the negative impacts of disasters. This includes measures aimed at reducing the physical, social, economic and environmental factors that contribute to vulnerability. Vulnerability reduction is a critical component of disaster risk management, as it focuses on addressing the underlying causes of vulnerability rather than simply responding to disasters after they occur. By reducing vulnerability, communities can improve their resilience to disasters and minimize the negative impacts on their lives and livelihoods.

There are a variety of strategies and approaches that can be used to reduce vulnerability, including:

1. **Strengthening infrastructure and building codes:** Ensuring that buildings, roads and other infrastructure are designed and built to withstand disasters and can reduce the physical vulnerability of communities.
2. **Improving early warning systems:** Developing effective early warning systems can provide communities with advanced notice of impending disasters, allowing them to take proactive measures to protect themselves.
3. **Enhancing social safety nets:** Developing social safety nets such as insurance, social welfare programs and community-based support networks can help to mitigate the social and economic impacts of disasters on vulnerable populations.

4. **Promoting sustainable development:** Sustainable development practices that prioritize environmental conservation, resource management and community participation can reduce the environmental and economic factors that contribute to vulnerability.
5. **Engaging in risk communication and education:** Effective in risk communication and education about disaster risk can help to raise awareness, build capacity and empower communities to take action to reduce their vulnerabilities.

Brundtland Commission, 1987 defined Sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organisation and social organisation on the environment's ability to meet present and the future needs. Thus, sustainable development is a pattern of development which fulfils the resource needs of the present generation without impending the resource needs of the future generations. Thus, sustainable development is a holistic approach to development that seeks to balance economic growth, social development, and environmental protection. Sustainable development can play a critical role in reducing vulnerability to disasters by addressing the underlying causes of vulnerability and building resilience.

Some of the ways sustainable development can help reduce vulnerability are:

1. **Addressing poverty and inequality:** This can help reduce vulnerability to disasters by improving living conditions and proving people with the resources they need to prepare for and respond to disasters.

2. **Strengthening Infrastructure:** Sustainable development can help improve infrastructure such as roads, bridges, and water supply systems making them more resilient to disasters. Building infrastructure that is resilient to disasters, such as earthquake-resistant buildings, flood-proof infrastructure, and early warning systems, can reduce vulnerability and promote long-term sustainability. This can reduce the impact of disasters on communities and enable faster recovery.
3. **Promoting sustainable land use:** Land use planning that considers the potential impact of disasters, such as avoiding development in flood-prone or landslide prone areas, can reduce vulnerability and promote sustainability.
4. **Enhancing environmental Protection:** Sustainable development seeks to protect the environment by reducing pollution, promoting renewable energy and restoring natural resources such as forests, wetlands, coastal areas etc. This can help reduce vulnerability to disasters by mitigating the impact of climate change and other environmental threats.
5. **Promoting community participation:** Sustainable development emphasizes the importance of community participation in decision-making processes. Building community resilience through community- based disaster risk management which includes training, awareness raising and participatory planning. This can help reduce vulnerability to disasters by ensuring that community members have a say in how their communities are prepared for and respond to disasters.
6. **Promoting innovation:** Promoting innovation in disaster risk reduction and management includes the development and adoption of new technologies and approaches can improve sustainability and reduce vulnerability.

Overall, sustainable development can help reduce vulnerability to disasters by addressing the root causes of vulnerability and

building resilience. By promoting economic growth that is an outcome of sustainable development, improving green infrastructure, protecting the environment, and promoting community participation, sustainable development can help ensure that communities are better prepared to cope with disasters and recover more quickly.

There have been several reports on sustainable development for vulnerability reduction. Some of the important reports are:

1. **The 2021 Human Development Report:** The United Development Programme (UNDP) released the 2021 Human Development Report, which focuses on the theme of vulnerability and resilience. The report argues that sustainable development must prioritize reduce vulnerabilities and building resilience, particularly for those who are most marginalized and disadvantaged. It also highlights the importance of addressing the root causes of vulnerability, such as poverty, inequality and discrimination.
2. **The Global Assessment Report on Disaster Risk Reduction:** The United Office for Disaster Risk Reduction (UNDRR) emphasized the need to align disaster risk reduction efforts with the Sustainable Development Goals (SDG), particularly SDG 11 which is on making cities and human settlements inclusive, safe, resilient and sustainable. It also highlighted the importance of integrating disaster risk reduction into national development plans and building resilience at the community level.
3. **The Sendai Framework for Disaster Risk Reduction 2015-2030:** In 2015, UNDRR adopted the Sendai Framework for Disaster Risk Reduction, which provides a roadmap for countries to reduce disaster risk and build resilience. The framework aligns with the SDGs and emphasizes the importance of integrating disaster risk reduction into development planning, investing in disaster risk reduction, and strengthening disaster risk governance.
4. **The IPCC Sixth Assessment Report:** The Intergovernmental Panel on Climate Change (IPCC) report highlights the severe impacts of

climate change on vulnerable populations such as those living in poverty, indigenous communities and small island states. It emphasizes the urgent need for action to reduce green-house gas emissions and build resilience to the impacts of climate change.



CHECK YOUR PROGRESS

Q.3: What is vulnerability reduction?

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Q.4: What is Sustainable development?

.....

Q.5: What are the sustainable development ways to reduce vulnerability?

.....



5.5 LET US SUM UP

- Disaster related vulnerability refers to the susceptibility of individuals, communities, and systems to the impacts of disasters.
- Disaster related vulnerability is influenced by a range of factors, including social, economic, environmental, and institutional factors.
- Disaster-related vulnerability can be reduced through a range of measures, including disaster risk reduction, disaster preparedness, emergency response, and post- disaster recovery and reconstruction.
- By reducing disaster related vulnerabilities, it is possible to build more resilient and sustainable communities that can better withstand and recover from disasters.
- Sustainable development aims to meet the needs of the present without compromising the ability of future generations to meet their own needs.

- Sustainable development is based on the principles of social, economic, and environmental sustainability and seeks to promote equity, resilience and long- term prosperity.
- Vulnerability in disaster refers to the susceptibility of people, communities, infrastructure and the environment to the impacts of disasters.
- Sustainable development can play a critical role in reducing vulnerability to disasters by addressing the underlying risk factors and vulnerabilities that contribute to disasters.
- Sustainable development can promote resilience by strengthening social, economic, and environmental systems to better withstand and recover from disasters.



5.6 FURTHER READING

1. Anderson, M. B. (1995). Vulnerability to disaster and sustainable development: A general framework for assessing vulnerability. Disaster Prevention for Sustainable Development: Economic and Policy Issues. Washington, DC: World Bank, 41-59.
2. McEntire, D. A. (2004). Development, disasters and vulnerability: a discussion of divergent theories and the need for their integration. Disaster Prevention and Management: An International Journal, 13(3), 193-198.
3. Robielos, R. A. C., Lin, C. J., Senoro, D. B., & Ney, F. P. (2020). Development of vulnerability assessment framework for disaster risk reduction at three levels of geopolitical units in the Philippines. Sustainability, 12(21), 8815.

5.7 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q.No.1: Development and vulnerability to disasters are two closely linked concepts and have been examined by many scholars and practitioners and concluded that a new strategy is needed to address both issues in a concurrent and comprehensive manner. Development refers to the process of economic, social, and political progress that improves the well-being of individuals and communities. Vulnerability, on the other hand refers to the susceptibility of individuals and communities to the negative impacts of disasters.

The relationship between development and vulnerability is complex. While development can improve the resilience of communities to disasters, it can also increase their vulnerability. For example, rapid urbanization and the growth of informal settlements can increase the vulnerability of communities to disasters such as floods or landslides. Similarly, economic development can lead to the expansion of industries that are susceptible to natural hazards, such as agriculture or tourism.

Ans. to Q. No. 2: Disaster-related vulnerability refers to the degree to which individuals, communities, or systems are susceptible to harm or negative impacts caused by natural or human-made disasters. Vulnerability can arise from a range of factors, including poverty, inadequate infrastructure, lack of access to resources, environmental degradation and social and economic inequality.

Ans. to Q. No. 3: Vulnerability reduction refers to the process of reducing the susceptibility of individuals, communities, and societies to the negative impacts of disasters. This includes measures aimed at reducing the physical, social, economic and environmental factors that contribute to vulnerability.

Ans. to Q. No. 4: Sustainable development is meeting the needs of the present without compromising the ability of future generations to meet their own needs. It is based on the principles of social, economic, and environmental sustainability and seeks to promote equity, resilience and long- term prosperity.

Ans. to Q. No. 5: Some of the sustainable development ways to reduce vulnerability are: addressing poverty and inequality, Improving Green Infrastructure, protecting the environment, promoting community participation, etc.

5.8 MODEL QUESTIONS

Q.1. How is development related to vulnerability?

Q. 2. What is disaster related vulnerability?

Q. 3. Explain some of the strategies and approaches that can be used to reduce vulnerability.

Q. 4. What is sustainable development and describe the to reduce vulnerability?

Q. 5. Highlight the importance of some of the recent reports on the sustainable development goals related to disaster reduction.

*** *** ***

UNIT- 6: UNDERSTANDING DISASTER MANAGEMENT

UNIT STRUCTURE

6.1 Learning Objectives

6.2 Introduction

6.3 Meaning of Disaster management

6.4 Disaster Management Cycle

6.5 Crisis Management

6.6 Risk Management

6.7 Let us Sum up

6.8 Further Readings

6.9 Answers to Check Your Progress

6.10 Model Questions

6.1 LEARNING OBJECTIVES

After going through this unit, you will be able to-

- explain the meaning of disaster management
- describe the disaster management cycle
- discuss the crisis management during disaster
- elaborate the risk management.

6.2 INTRODUCTION

In the previous unit we have discussed the issues related to development and vulnerability to disaster. In this unit we are going to discuss the meaning of disaster management. The disaster management cycle

and the crisis management during disaster will also be discussed in this unit. This unit will also focus on risk management.

6.3 MEANING OF DISASTER MANAGEMENT

Disaster management refers to the process of preparing for, responding to, recovering from, and mitigating the effects of natural or man-made disasters. It involves a range of activities and measures aimed at reducing the risk and impact of disasters on people, communities, infrastructure, and the environment. Pearce (2000) defines disaster management as "a process that assists communities to respond, both pre- and post-event, in such a way as to save lives, to preserve property; and to maintain the ecological, economic, and political stability of the impacted region."

Phases of Disaster Management: The important phases of activity within disaster management are:

1. **Pre-Disaster:** This phase is before a disaster to reduce the potential for human, material or environmental losses caused by hazards and to ensure that these losses are minimized when the disaster actually strikes.
2. **During Disaster:** This phase ensures the need and provisions of victims and is met to alleviate and minimize suffering.
3. **Post-Disaster:** After a disaster how to achieve rapid and durable recovery which does not reproduce the original vulnerable conditions.

Disaster management begins with preparedness activities, which involve preparing for disasters before they occur. This may include developing emergency plans, training emergency responders and community members and stockpiling necessary supplies and equipment. In the event of a disaster, emergency responders and communities work together to respond to the immediate impacts of the disaster and save

lives and property. This may involve search and rescue operations, providing emergency medical care and shelter, and evacuating affected populations.

The Disaster Management Act, 2005 defines disaster management as an integrated and continuous process of planning, organizing, co-ordinating and implementing measures which are necessary for-

1. Prevention of threat of any disaster.
2. Mitigation of risk of any disaster or its consequences.
3. Preparedness in dealing with a disaster.
4. Response to any threat or disaster.
5. Assessing the magnitude of the effects of any disaster.
6. Evacuation, Rescue and relief.
7. Rehabilitation and Reconstruction.

Thus, Disaster management is the process of effectively preparing for and responding to the disasters. A typical disaster management comprises of Pre-disaster phase and goes beyond post- disaster phase. It involves all levels of government. Non-governmental and community-based organizations also play a vital role in the process. Modern disaster management goes beyond post-disaster assistance. It now includes pre-disaster planning and preparedness activities, organizational planning, training, information management, public relations and many other fields. Crisis management is important, but is only a part of the scope and responsibility of a disaster manager. The newer paradigm is the Total Risk Management (TRM) which takes a holistic approach to risk reduction.



CHECK YOUR PROGRESS

Q.1: What is disaster management?

.....

Q.2: What is the significance of disaster management?

.....

6.4 DISASTER MANAGEMENT CYCLE

The disaster management cycle illustrates the process for, responding to, recovering from, and mitigating the impacts of disasters. It is a continuous process by which a range of government agencies, non-governmental organizations and communities plan for and reduce the impact of disasters, react during and immediately after a disaster and take necessary steps to recover after a disaster has taken place. The suitable acts at all points in the cycle lead to greater preparedness, better warnings, reduced vulnerability or the prevention of disasters during the next recurrence of the cycle. The complete disaster management cycle includes the shaping of public policies and plans that either modify the causes of disasters or mitigate their effects on people, property and infrastructure. Thus, this cycle is a framework that outlines the key stages of managing disasters, emergencies or crisis. The cycle (Fig 6.1) consists primarily of four main stages, which are:

1. **Preparedness:** This stage involves planning and preparing for potential disasters or emergencies. This includes assessing potential risks and vulnerabilities, developing emergency response plans, and conducting training and drills for emergency responders and the general public. Thus, it tends to be strongly oriented towards action by individual organizations at large. E.g., mock exercises, public awareness activities etc.
2. **Response/Relief:** This stage is a post-disaster activity and so involves responding to the immediate aftermath of a disaster or emergency. The main aspects involve search and rescue operations, providing medical care and emergency services, and evacuating affected individuals and communities to safety. The effectiveness of response depends on the type of disaster, severity and extent of disaster, efficient pre- impact action and effective identification of requirement. Response stage may take certain weeks to months.

3. **Recovery:** This stage involves recovering from the impact of the disaster or emergency. The main aspects are rehabilitation and reconstruction. Rehabilitation involves restoring basic services such as electricity, water, and sanitation etc. and reconstruction involves full resumption of services such as repairing infrastructure and buildings, and providing support to affected individuals and communities. It takes months to years depending on the response processes.
4. **Mitigation:** This stage involves taking steps to prevent or reduce the impact of future disasters or emergencies. This involves implementing measures such as building codes and zoning regulations, conducting hazard assessments and risk reduction activities, and promoting public education and awareness.

Mitigation can be classified into two categories. Structural mitigation and non-structural mitigation.

Structural mitigation: It involves the physical changes and modifications made to the environment, infrastructure, and buildings to mitigate the impact of disasters. These measures are implemented during the design and construction phases to enhance the resilience of communities and infrastructure.

Non-structural Measures: Non-structural measures focus on strategies and actions that do not involve physical changes to the environment but aim to enhance preparedness, response, and recovery capabilities. These measures involve policy, planning, and community-based approaches.

The disaster management cycle is an ongoing process, with each stage building upon the previous one. Effective disaster management requires a coordinated and integrated approach that involves government agencies, emergency responders, non-governmental organizations, and affected communities.

The table (Table 6.1) shows the different stages and steps or measures that can be taken in different disasters.

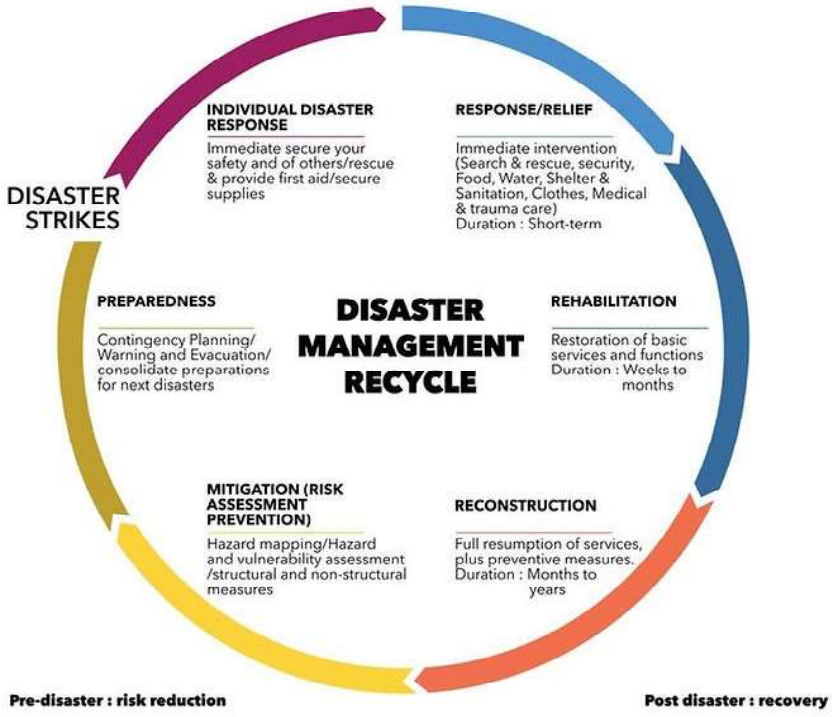


Figure 6.1: The Disaster Management Cycle

(Source/Licence: https://creativecommons.org/licenses/by/3.0/)

Table 6.1: Example showing measures in Each Disaster Risk Management Phase.

Disaster/ Phase	Earthquake	Flood	Storm (cyclone, typhoon, hurricane)	Landslide
Prevention/ Mitigation	- Seismic design. - Retrofitting of vulnerable buildings. -Installation of seismic isolation. -seismic response control systems.	-Construction of dike. - Building of dam. - Forestation. - Construction of flood control basins/ reservoirs.	-Construction of tide wall. - Establishment of forests to protect against storms.	Construction of erosion control dams - Construction of retaining walls

Preparedness	Construction and operation of earthquake observation systems	-Construction and operation of meteorological observation systems	-Construction of shelter. - Construction and operation of meteorological observation systems	-Construction and operation of meteorological observation systems
	-Preparation of hazard maps - Food & material stockpiling - Emergency drills - Construction of early warning systems - Preparation of emergency kits.			
Response	-Rescue efforts - First aid treatment - Fire fighting - Monitoring of secondary disaster - Construction of temporary housing - Establishment of tent villages			
Rehabilitation/ Reconstruction	- Disaster resistant reconstruction - Appropriate land use planning - Livelihood support - Industrial rehabilitation planning			



CHECK YOUR PROGRESS

Q.3: What are disaster management cycle?

.....

Q.4: What are the stages of disaster management cycle?

.....

6.5 CRISIS MANAGEMENT

A crisis occurs just after the outbreak of an event or disaster and is a temporary state of emotional turmoil and disorganization. The immediate actions taken during the disaster or emergency period to check or control the situation is known as crisis management. Thus, crisis management is

an essential component of disaster management. Disasters can create a state of emergency and pose significant risks to the affected populations and environments. Crisis management is the process of identifying, assessing, and managing the response to a crisis situation, such as a natural disaster, to minimize the impact of the event.

Crisis management in disaster management involves several activities.

1. **Pre-disaster planning:** This includes identifying potential risks and hazards, developing a disaster response plan, and preparing personnel and resources to respond to a disaster.
2. **Early warning and detection:** This involve monitoring the potential for a disaster to occur and providing timely warning to the population and authorities to take action.
3. **Response:** This includes activating the disaster response plan, coordinating the deployment of personnel and resources to affected areas and providing critical services such as search and rescue, medical care and shelter.
4. **Communication:** This involves ensuring effective communication among responders and stack-holders, including the affected population, to provide timely and accurate information about the situation, response efforts and recovery efforts.
5. **Recovery:** This includes restoring essential services, infrastructure, and housing, providing long-term support and care for affected populations, and implementing measures to prevent future disasters.

Crisis management in disaster management requires collaboration among various agencies, organizations, and individuals to ensure an effective response. Effective crisis management can help in reducing the impact of disasters and promote rapid recovery, in affected areas and of populations.

6.6 RISK MANAGEMENT

Risk is a measure of the expected losses due to a hazardous event of a particular magnitude occurring in a given area over a specific time period. It is a function of the probability of particular occurrences and the losses each could cause. The level of risk depends on natural hazard, vulnerability of the elements which are affected and economic value of those elements.

Risk management is a critical aspect of disaster management. It involves the identification, assessment, and prioritization of risks associated with potential disasters, as well as the implementation of strategies to minimize the impact of those risks.

In disaster management, risk management involves several key activities. Some of the activities are discussed below.

1. **Risk assessment:** This involves identifying potential hazards and risks associated with disasters, such as natural disasters or pandemics. Risk assessments can help to identify the likelihood and potential impact of various scenarios, as well as the vulnerabilities of affected populations and infrastructure.
2. **Risk mitigation:** This involves implementing measures to reduce the likelihood and severity of potential disasters. Examples of risk mitigation strategies include building disaster-resistant infrastructure, creating early warning systems, and implementing disaster preparedness plans.
3. **Risk transfer:** This involves transferring the financial risk associated with disasters to insurance providers or other organizations. This can help to reduce the financial impact of disasters on affected individuals, communities and businesses.
4. **Risk communication:** This involves providing timely and accurate information about potential risks, as well as strategies to mitigate those risks, to the affected population and stakeholders. Effective

risk communication can help to build trust and promote collaboration among responders and affected populations.

5. **Risk recovery:** This involves implementing measures to promote the recovery and rehabilitation of affected populations and infrastructure. Examples of risk recovery measures include providing support for displaced individuals, repairing damaged infrastructure, and implementing measures to prevent future disasters.

Effective risk management is essential to disaster management because it helps to reduce the impact of disasters on affected populations, promote rapid recovery, and prevent future disasters. It requires collaboration among agencies, organizations, and individuals to ensure an integrated and co-ordinated response.



6.7 LET US SUM UP

- Disaster management is the process of preparing for, responding to, recovering from, and mitigating the impacts of disasters.
- Disaster risk reduction refers to the systematic efforts and strategies aimed at reducing the risk of disasters, minimizing their impacts and enhancing the resilience of communities and societies.
- Effective disaster management requires coordination and collaboration among stakeholders at all levels, from local communities to national and international organizations.
- The disaster management cycle refers to the process of preparing for, responding to, recovering from, and mitigating the impacts of disasters.
- The outcome of any disaster is crisis situation, which arises because of the sudden disruption in the socio-economic system and communication network.

- Effective crisis management involves a range of activities such as developing a disaster management plan, risk assessment and scenario planning, communication, training and simulation exercises, disaster response, recovery and evaluation etc.
- Mitigation can be classified into two categories namely structural mitigation and non-structural mitigation
- Risk assessment is a critical component of disaster management, as it helps to identify potential hazards and vulnerabilities and determine the likelihood and potential impact of a disaster.
- The risk assessment process involves the steps such as hazard identification, vulnerability analysis, risk estimation, risk evaluation, risk communication etc.
- The risk assessment process is an ongoing process that should be regularly reviewed and updated to reflect changing circumstances and new information.



6.8 FURTHER READINGS

1. Carter, W. N. (2008). Disaster management: A disaster manager's handbook.
2. Elliott, D. (2014). Disaster and Crisis Management. In: Gill, M. (eds) The Handbook of Security. Palgrave Macmillan, London. https://doi.org/10.1007/978-1-349-67284-4_36



6.9 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1: Disaster management refers to the process of preparing for, responding to, recovering from, and mitigating the effects of natural or man-made disasters. It involves a range of activities and measures aimed

at reducing the risk and impact of disasters on people, communities, infrastructure, and the environment.

Ans. to Q. No. 2: As per Disaster Management Act, 2005, "disaster management" means a continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary for:

1. Prevention of threat of any disaster.
2. Mitigation of risk of any disaster or its consequences.
3. Preparedness in dealing with a disaster.
4. Response to any threat or disaster.
5. Assessing the magnitude of the effects of any disaster.
6. Evacuation, Rescue and relief.
7. Rehabilitation and Reconstruction.

Ans. to Q. No. 3: The disaster management cycle is a framework that outlines the phases of disaster management, from preparedness to recovery.

Ans. to Q. No. 4: The disaster management cycle includes the following stages:

Preparedness, Mitigation, Response, Recovery and Prevention.

6.10 MODEL QUESTIONS

Q.1: Illustrate with diagram the disaster management cycle.

Q.2: Why is crisis management important?

Q.2: Explain the activities involved in risk management.

*** *** ***

UNIT- 7: DISASTER MANAGEMENT ACT

UNIT STRUCTURE

7.1 Learning Objectives

7.2 Introduction

7.3 Institutional Framework for Disaster Management in India

7.4 Disaster Management Act

7.5 National Disaster Management Authority (NDMA)

7.6 State Disaster Management Authority (SDMA)

7.7 District Disaster Management Authority (DDMA)

7.8 Disaster Management Authorities at Local Level

7.9 Let us Sum up

7.10 Further Reading

7.11 Answers to Check Your Progress

7.12 Model Questions

7.1 LEARNING OBJECTIVES

After going through this unit, you will be able to-

- elaborate Institutional Framework for Disaster Management in India
- distinguish Disaster Management Act 2005
- recognize duties and responsibilities of disaster management authorities in India at national, state, district and local level.

7.2 INTRODUCTION

In the previous unit, we discussed the management of disaster. In this unit, we will provide background information on the institutions

responsible for disaster management in India. Additionally, we will describe the Disaster Management Act. This unit will also cover the duties and responsibilities of disaster management authorities at the national, state, district, and local levels in India.

7.3 INSTITUTIONAL FRAMEWORK FOR DISASTER MANAGEMENT IN INDIA

Until 2001, responsibility of disaster management in India was with Agriculture Ministry. Responsibility was shifted to Ministry of Home Affairs (MoHA) in June 2002. Disaster Management Act was passed in December 2005 from a response and relief-centric approach to a holistic approach covering prevention, preparedness, capacity building, mitigation, rehabilitation, recovery & reconstruction. Ministry of Home Affairs is the Nodal Ministry at the centre for coordinating disaster management activities for all natural disasters except drought. Major institutions for disaster management in India:

- National Disaster Management Authority (NDMA)
- National Institute of Disaster Management (NIDM)
- National Disaster Response Force (NDRF)
- Integrated Data Resource Network (IDRN)

NDMA

The National Disaster Management Authority (NDMA), headed by the Prime Minister of India, is the apex body for Disaster Management in India. More information on NDMA is given separately. NDMA is the apex policy advisory body of Government of India. Established under Disaster Management Act 2005, NDMA prepares National Policy & Plans, issue guidelines and ensure its implementation through nodal ministries and line departments.

NIDM

National Institute of Disaster Management (NIDM) is another statutory organisation established under DM Act 2005. It functions under the supervision of NDMA and provide training and research in the field of disaster management. NIDM was formed as National Centre for Disaster Management (NCDM) in 1995 but was re-designated as National Institute of Disaster Management in 2005 after the enacting of the Disaster Management Act. The institute is headed by the Union Home Minister. The institute has five divisions i.e., Geo-Hazard Division; Hydro-Met Hazard Division; Policy Planning and Cross Cutting Issues Division; Response Division; and Administrative and Finance Division.

NDRF

NDRF was constituted in 2006 with 8 battalions drawn from the paramilitary forces. Presently it has strength of 10 battalions. These battalions are positioned at different locations to provide timely response to disaster situations and are available to State Governments at the time of need.

The force provides specialized response during disasters, is pro-actively deployed in impending disaster situations, imparts training to state disaster response force personnel and conducts programmes for creating awareness and community capacity building.

IDRN

Integrated Data Resource Network is a database in the electronic form maintained by the Ministry of Home Affairs. The data enlists inventory of equipment and human resources relevant to disaster management.

Other Institutional Arrangements:

Cabinet Committee on Management of Natural Calamities (CCMNC) has been constituted to oversee all aspects relating to the management of natural calamities.

National Calamity Contingency Fund (NCCF) was created in 2000-01 by the Government of India with a corpus fund of Rs.500 crores and the objective was to provide assistance to disaster affected states and regions. Armed forces are called upon to assist the civil administration when the situation is beyond their capability to respond to, and manage. Armed forces have played a major role in emergency support functions like communication, search and rescue operations, providing medical facilities and transportation, etc.

Central Paramilitary forces also play a key role at such times for immediate response to disasters.

State Police and Fire Services are crucial immediate responders to disasters and hence are required to improve their response capabilities. Civil Defense Act has been amended in 2009 to bring disaster management into the area of operation of civil defense agencies.

International agencies also play a role in disaster management. UNDP along with NDMA took up Disaster Risk Reduction (DRR) and Urban Risk Reduction programmes. World Bank is associated with National Cyclone Risk Mitigation Project (NCRMP) which is being taken up in Andhra Pradesh and Orissa. Red Cross Society also provides valuable support during relief operations.



CHECK YOUR PROGRESS

Q.1: What are the major institutions for disaster management in India?

.....

Q.2: Who is the head of NDMA?

.....

7.4 DISASTER MANAGEMENT ACT

A disaster means a "catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes. The

Disaster Management Act (DMA) was enacted in India on 26th December, 2005. It came into effect in the aftermath of the 2004 tsunami in Indian Ocean that hit the coasts of several countries of South and Southeast Asia including India and thousands of people died. The Act was passed by the government for efficient management of disasters, including preparation of mitigation strategies, capacity-building and related matters.

Provisions of DMA

- The Act aims to manage disasters, including preparation of mitigation strategies, capacity-building and a lot more.

The Act also designates the Ministry of Home Affairs as the nodal ministry responsible for looking after the overall national disaster management in the country.

The Act also contains provisions for financial mechanisms including creation of funds for emergency response like the National Disaster Response Fund.

Governing bodies those were established under DMA

The National Disaster Management Authority (NDMA) is the nodal central body for disaster management coordination, with the Prime Minister as its Chairperson. It is responsible for framing the policies, plans and guidelines for disaster management to ensure an effective & strong response during any disaster.

Second is the National Executive Committee (NEC) which assists NDMA & prepares National Disaster Management Plan for the whole country.

At the state and district level, we have **State Disaster Management Authority (SDMA & District Disaster Management Authority (DDMA)** responsible for drawing the disaster plan for states & districts respectively.

Then, there is **National Disaster Response Force** (NDRF) which directly responds to a disasters and calamities. The NDRF has been playing a major role in rescuing people from disasters for years.

Phases of DMA

Disaster Management undergoes four phases:

- Mitigation: Mitigation ensures proper precautions and proactive measures before a disaster occurs
- Preparedness: Preparedness refers to hosting emergency training sessions before the occurrence of the disaster
- Response: It is the reaction to the disaster phase. The response can be both short-term and long-term effects
- Recovery: The stage of recovery is sustaining and prioritization of individual necessities

Relevant sections of DMA

- Section 6: It gives NDMA the powers to prepare national plans for disaster management. It also ensures the implementation of the plan through the state disaster management authorities.
- Section 10: It allows the NEC to give directions to governments regarding measures to be taken by them.
- Section 33: It says that the District Authority may order any officer or any Department at the district level or any local authority to take such measures for the prevention or mitigation of disaster. Such officer or department shall be bound to carry out such order.

Penalties under the Disaster Management Act 2005

The DMA immensely empowers the NDMA and the central government. So much so that regardless of any law in effect, the Central Govt can issue instructions to any authority anywhere in India to assist and contribute in disaster management. Failure to follow such directions leads to violation of the act.

Chapter 10 of the Act deals with 'Offences and Penalties'.

- Under Section 51, anyone refusing or failing to follow orders is liable for punishment with imprisonment up to one year, or fine, or both.
- Article 52 guarantees imprisonment for almost two years and a fine being imposed on any person making false claims to gain

relief benefits. Article 54 enforces imprisonment of one year or a fine on anyone circulating false alarms about the severity of a disaster.

Criticism of Disaster Management Act 2005

Disaster Management Act in India has been praised for addressing significant gaps in disaster management. However, it has also faced criticism for certain shortcomings. Those shortcomings or challenges are mentioned below:

Absence of disaster prone zones: Almost all disaster related legislations in the world have mapped out disaster- prone zones within their respective jurisdictions. But there is no provision in the Act. The state cannot be expected to play a pro- active role unless an area is declared 'disaster-prone'.

Neglects progressive behaviour of disasters: The Act portrays every disaster as a sudden occurrence and completely fails to take into account that disasters can be progressive in nature as well.

In 2006, over 3,500 people were affected by dengue, a disease with a history of outbreaks in India, yet no effective mechanism has been put in place to check such an ordeal.

Tuberculosis is known to kill thousands of people in the country each year but since its occurrence is not sudden or at once, it has not found a place in the Act.

Overlapping Functions: The Act calls for establishment of multiple-national level bodies, the functions of which seem to be overlapping, making coordination between them difficult.

The local authorities, who have a very valuable role to play in the wake of any disaster as first responders, barely find a mention in the Act. There are no substantive provisions to guide the local bodies.

Procedural Delays and Inadequate Technology: Delayed response, inappropriate implementation of the plans and policies, and procedural lags plague the disaster management scheme in India. Inadequate technological

capacity for accurate prediction and measurement of the disaster result in large scale damage.



CHECK YOUR PROGRESS

Q.3: : What is the Disaster Management Act 2005?

.....

Q.4: When was the Disaster Management Act, 2005 made effective from?

.....

7.5 NATIONAL DISASTER MANAGEMENT AUTHORITY (NDMA)

The National Disaster Management Authority (NDMA) was formally constituted on 27th September 2006, in accordance with the Disaster Management Act, 2005, with the Prime Minister as its Chairperson and nine other members, and one such member to be designated as Vice-Chairperson. NDMA is responsible for laying down policies, plans and guidelines for disaster management for ensuring timely and effective response to disaster.

NDMA is to be assisted by a National Executive Committee which comprises of Secretaries to the Government of India heading various Ministries or Departments having administrative control over Agriculture, Atomic Energy, Defense, drinking water supply, environment and forests, finance, health, power, rural development, science and technology, space, telecommunication, urban development and water resources.

National Executive Committee is responsible for preparing and updating a National Plan for disaster management. The Plan includes measures to be taken for prevention of disasters or the mitigation of their effects; measures to be taken for the integration of mitigation measures in

the development plans; measures to be taken for preparedness and capacity building to effectively respond to any threatening disaster situation or disaster; and defining the roles of various departments in respect of these measures.



CHECK YOUR PROGRESS

Q.5: What is the role of the National Disaster Management Authority?

.....

.....

7.6 STATE DISASTER MANAGEMENT AUTHORITY (SDMA)

The Disaster Management Act 2005 also provides for setting up of State Disaster Management Authorities under the Chairpersonship of the Chief Minister. State Authority is to be assisted by a State Executive Committee under the Chairpersonship of the Chief Secretary of the State. The Committee prepares a state plan which would include assessment of vulnerability of different parts of the state to different forms of disasters; measures to be adopted for prevention and mitigation of disasters; capacity building; and role of departments of State Government. Apart from the planning aspect it is also involved in taking up and supervising relief and rescue operations at the time of disaster and in disseminating information about any impending disaster.



CHECK YOUR PROGRESS

Q.6: Who is the Chairperson of SDMA and State Executive Committee?

.....

7.7 DISTRICT DISASTER MANAGEMENT AUTHORITY (DDMA)

The structure of disaster management institutions goes down to the district level where the responsibility is given to DDMA which is headed by the Collector/ District Magistrate with elected representative of the local authority as co-chairperson. DDMA acts as the planning, coordinating and implementing body for disaster management at the district level.

DDMA prepares the District Plan for disaster management in accordance with instructions by NDMA and SDMA. The DDMA also ensures that the guidelines for prevention, mitigation, preparedness and response measures laid down by the NDMA and the SDMA are followed by all the Departments of the State Government at the District level and the local authorities in the District.



CHECK YOUR PROGRESS

Q.7: Who is the head of DDMA?

.....

7.8 DISASTER MANAGEMENT AUTHORITIES AT LOCAL LEVEL

Local bodies being physically nearer to the people, are in a better position to undertake disaster management tasks as they are more familiar to the requirements of the local people, besides knowing the local terrain. Effective and strong Panchayati Raj Institutions, working in harmony with the state government, can help in tackling a disaster through early warning systems.

Local government institutions have grass root level contact with people and they can help effectively in spreading awareness and ensure people's participation in fighting the crisis.

They are also ideal channels for NGOs and other agency's participation in the rescue and relief operations.

Local bodies are required to ensure capacity building of their employees for managing disasters and carrying out relief and reconstruction activities in the affected areas.



7.9 LET US SUM UP

- Disaster Management Act was passed in December 2005 from a response and relief-centric approach to a holistic approach covering prevention, preparedness, capacity building, mitigation, rehabilitation, recovery & reconstruction.
- NDMA, NIDM, NDRF, IDRN are major institutions for disaster management in India.
- NDMA is headed by the Prime Minister and NIDM is headed by the Union Home Minister.
- National Disaster Management Authority, National Executive Committee, State Disaster Management Authority, District Disaster Management Authority and National Disaster Response Force were established by DMA 2005.
- The NDMA was formally constituted on 27th September 2006.
- The Disaster Management Act 2005 provides for setting up of State Disaster Management Authorities and District Disaster Management Authorities.
- Panchayati Raj institution can play a major role in disaster management at local level.



7.10 FURTHER READINGS

- *The Disaster Management Act, 2005 by Bare Act, 2023, Commercial Law Publishers (India) Pvt. Ltd.*
- *The Disaster Management Act, 2005 with Rules, Regulations and Notifications with Special Reference to COVID-19 by P.V. Dhopatkar, Notion Press*
- *https://nidm.gov.in/*
- *https://ndma.gov.in/*



7.11 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q.No.1: Major institutions for disaster management in India: National Disaster Management Authority (NDMA). National Institute of Disaster Management (NIDM), National Disaster Response Force (NDRF), Integrated Data Resource Network (IDRN).

Ans. to Q.No.2: The Prime Minister is the head of NDMA.

Ans. to Q.No.3: The Disaster Management Act of 2005 (DMA 2005) is an act passed by the government of India for the 'efficient management of disasters and other matters connected to it.

Ans. to Q.No.4: The Disaster Management Act, 2005 was made effective from December 23, 2005.

Ans. to Q.No.5: The role of the National Disaster Management Authority are:

i) Laying down policies for disaster management

ii) Approving the plans prepared by different concerned Departments

iii) Draw a National and State Plan

Ans. to Q.No.6: Chief Minister is the Chairperson of SDMA and the Chief Secretary is the Chairperson of State Executive Committee.

Ans. to Q.No.7: Collector or District Magistrate is the head of DDMA.



7.12 MODEL QUESTIONS

Q.1: Write name of international agencies which play role in disaster management?

Q.2: What is the Disaster Management Act, 2005?

Q.3: In which city the National Institute of Disaster Management is situated?

Q.4: What are the differences between NDMA and NIDM?

Q.5: What are the functions of NDMA?

Q. 6: What are the roles and responsibilities of SDMA and DDMA in disaster management?

*** *** ***

UNIT- 8: DISASTER RISK REDUCTION (DRR)

UNIT STRUCTURE

8.1 Learning Objectives

8.2 Introduction

8.3 Idea of Disaster Risk Reduction

8.4 Mitigation Measures: Structural

8.5 Mitigation Measures: Non- Structural

8.6 Let us Sum up

8.7 Further Reading

8.8 Answers to Check Your Progress

8.9 Model Questions

8.1 LEARNING OBJECTIVES

After going through this unit, you will be able to-

- explain concepts and guidelines of disaster risk reduction
- get an idea of structural and non-structural disaster mitigation measures.

8.2 INTRODUCTION

In the previous unit, you have learnt about the institutional framework for disaster management in India. In this unit, we are going to provide you an idea of disaster risk reduction and its framework.

Risk is a measure of the expected losses due to a hazard event occurring in a given area over a specific time period. Risk is a function of the probability of particular hazardous event and the losses each would cause. In many cases, it is not easy to avoid or reduce a hazard or its impacts. But one can reduce the expected losses, i.e., risk, if appropriate measures are taken in

proper time. Hence, disaster risk reduction is more acceptable than disaster reduction. In this chapter, you will also learn about structural and non-structural measures of disaster mitigation.

8.3 IDEA OF DISASTER RISK REDUCTION

Historically, dealing with disasters focused on emergency response. But towards the end of the 20th century, it was increasingly recognized that by reducing and managing conditions of hazard, exposure and vulnerability, we can prevent losses and alleviate the impacts of disasters. Since we cannot reduce the severity of natural hazards, the main opportunity for reducing risk lies in reducing vulnerability and exposure. Reducing these two components of risk requires identifying and reducing the underlying drivers of risk. Addressing underlying risk drivers will reduce disaster risk, lessen the impacts and, consequently, maintain the sustainability of development.

Disaster risk reduction (DRR) is a systematic approach to identifying, assessing and reducing the risk of disaster. DRR protects the lives and livelihoods of communities and individuals who are most vulnerable to disasters or emergencies. Whether the crisis is caused by nature or humans (or a combination of both), DRR limits its negative impact on those who stand to lose the most.

In some cases, we can reduce the size of a disaster, its strength, or even how frequently it occurs. DRR focuses specifically on the three key dimensions of disaster risk:

- Exposure to hazards
- Vulnerability and capacity
- Characteristics of each hazard

Being a part of sustainable development, DRR must involve every part of society, government, non-governmental organizations and the professional and private sector. It therefore requires a people-centred and

multi-sector approach, building resilience to multiple, cascading and interacting hazards and creating a culture of prevention and resilience.



Figure 8.1: Disaster Risk Reduction System

Successful DRR results from the combination of top-down, institutional changes and strategies, with bottom-up, local and community-based approaches. Approaches need to address the different layers of risk (from intensive to extensive risk), underlying risk drivers, as well as be tailored to local contexts. Before being able to reduce risk, one needs to understand the hazards, and the exposure and vulnerability of people and assets to those hazards.

In 2021, the Emergency Event Database (EM-DAT) recorded 432 disastrous events related to natural hazards worldwide. Asia was the most severely impacted, suffering 40% of all disaster events and accounting for 49% of the total number of deaths and 66% of the total number of people affected.

Every year, more than 200 million people are affected by droughts, floods, cyclones, earthquakes, fires, and other hazards. Increased population densities, environmental degradation, and global warming adding to poverty make the impacts of natural hazards worse. The past few years have reminded us that natural hazards can affect anyone and anywhere. From the tsunami in the Indian Ocean to the earthquakes in South Asia, from the devastation caused by hurricanes and cyclones in the United States and in the Caribbean and the Pacific, to heavy flooding across Europe and

Asia, hundreds of thousands of people have lost their lives, and millions their livelihoods, to disasters caused by natural hazards. While many know the human misery and crippling economic losses resulting from disasters, what few realize is that this devastation can be prevented through disaster risk reduction initiatives. Governments around the world have committed themselves to take action to reduce disaster risk, and have adopted a guideline to reduce vulnerabilities to natural hazards.

World Conference on Natural Disaster Reduction (WCNDR)

In 1994, the World Conference on Natural Disaster Reduction held in Yokohama, Japan, which adopted the Yokohama Strategy and declared the decade 1990-2000 as the International Decade for Natural Disaster Reduction (IDNDR). The Conference provided a unique opportunity to promote a strategic and systematic approach to reducing vulnerabilities and risks to hazards. It underscored the need for, and identified ways of, building the resilience of nations and communities to disasters.

The **Hyogo Framework for Action** (HFA) was a 10-year plan (2005-2015) adopted in January 2005 by 168 Member States of the United Nations at the World Conference on Disaster Reduction to make the world safer from natural hazards. Priorities such as, Disaster risk reduction, identification, assessment through legal and policy frameworks, disaster preparedness and use of innovation was adopted.

The Sendai Framework for Disaster Risk Reduction 2015-2030

The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted at the Third United Nations World Conference on Disaster Risk Reduction, held from 14 to 18 March 2015 in Sendai, Japan, which represented a unique opportunity for countries:

(a) To adopt a concise, focused, forward-looking and action-oriented post 2015 framework for disaster risk reduction;

(b) To complete the assessment and review of the implementation of the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters;

(c) To consider the experience gained through the regional and national strategies/ institutions and plans for disaster risk reduction and their recommendations, as well as relevant regional agreements for the implementation of the Hyogo Framework for Action;

(d) To identify modalities of cooperation based on commitments to implement a post 2015 framework for disaster risk reduction;

(e) To determine modalities for the periodic review of the implementation of a post 2015 framework for disaster risk reduction.

The framework outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks:

(i) Understanding disaster risk;

(ii) Strengthening disaster risk governance to manage disaster risk;

(iii) Investing in disaster reduction for resilience and;

(iv) Enhancing disaster preparedness for effective response.

The Sendai Framework covers technological hazards, in addition to natural hazards, which represent an evolution compared to its predecessor, the Hyogo Framework for Action. These technological hazards include chemical/industrial hazards further to radiological, nuclear, biological, and others.

The Sendai framework aims to achieve the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the 15 years.



Figure 8.2: Seven global targets outlined by Sendai Framework

(Source: https://www.undrr.org/implementing-sendai-framework/what-sendai-framework)

India is a signatory to the Sendai Framework and has implemented various policies in the direction of disaster risk reduction.

National Disaster Management Plan (NDMP) is a comprehensive plan to make India disaster resilient and to minimize the effects of damages caused during and in the aftermath of disasters and natural calamities. The NDMP was first released in 2016. The plan was updated in 2018. It is based on the Sendai framework and serves as a guideline for government agencies during a time of disaster.

As per the NDMP, there are six thematic areas for action in which the central and the state governments should function. They are:

i) Mainstream and integrate DRR and Institutional Strengthening
ii) Capacity Development
iii) Promote Participatory Approaches
iv) Work with Elected Representatives
v) Grievance Redress Mechanism
vi) Promote Quality Standards, Certifications, and Awards for Disaster

NDMP covers all the following phases of disaster management:

- Prevention
- Mitigation
- Response
- Recovery



CHECK YOUR PROGRESS

Q.1: What is disaster risk reduction?

.....

Q.2: What are the objectives of Sendai framework for disaster risk reduction?

.....

8.4 MITIGATION MEASURES: STRUCTURAL

Mitigation is defined as any sustained effort undertaken to reduce a hazard risk through the reduction of the likelihood and/or the consequence component of that hazard's risk. Thus, mitigation embraces measures taken to reduce both the effect of the hazard and the vulnerable conditions to it in order to reduce the scale of a future disaster.

Structural mitigation measures are any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resilience in structures or systems.

Common structural measures for disaster risk reduction include dams, flood levies, ocean wave barriers, earthquake-resistant construction and evacuation shelters. The general structural mitigation measures can be grouped as:

- **Resistance construction:** Through awareness and education, individual, corporate, and government entities can be informed of the hazards that exist and the measures that can be taken to mitigate the risks of those hazards, allowing resistant construction to be considered.
- **Structural modification:** Scientific progress and ongoing research continually provide new information about hazards.
- **Construction of community shelters:** The lives of community residents can be protected from a disaster's consequences though the construction of shelters designed to withstand a certain type or range of hazard consequences.
- **Construction of barrier, deflection, or retention systems:** The forces that many hazards exert upon man and the built environment can be controlled through specially engineered structures like barriers, deflection system, and retention systems.
- **Detection systems:** Detection systems are designed to recognize a hazard that might not otherwise be perceptible to humans. They have applications for natural, technological, and international hazards.

- **Treatment systems:** Treatment systems seek to remove a hazard from a natural system that humans depend on. These systems may be designed for non-stop use or for use in certain circumstances where a hazard is known to be present.
- **Redundancy in life safety infrastructure:** Redundancy in life safety infrastructure is important structural mitigation measure. Example of life systems into which redundancy may be built include:
    - Electricity infrastructure
    - Public Health Infrastructure
    - Emergency management infrastructure
    - Water storage, treatment, conveyance, and delivery systems
    - Transportation infrastructure
    - Irrigation systems
    - Food delivery



CHECK YOUR PROGRESS

Q.3: Give examples of structural measures in disaster risk reduction.

.....

Q.4: What are the uses of construction of barriers?

.....

8.5 MITIGATION MEASURES: NON STRUCTURAL

Non-structural measures use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education.

Common non-structural measures include building codes, land-use planning laws and their enforcement, research and assessment, information resources and public awareness programmes.

Various categories of non- structural mitigation measures are mentioned below:

- **Regulatory measures:**

Regulatory measures limit hazard risk by legally dictating human actions. A few important regulatory measures are: Land use management (Zoning), open space preservation (green spaces), Protective resource preservation, denial of services to high-risk areas, building use regulation, environmental protection regulation,

- **Community awareness and education programmes:**

The public can protect themselves from the effects of a hazard if they are first informed that the hazard exists, and then educated about what they can do to limit their risk.

- **Behavioral modification:**

Through collective action, a community can alter the behavior of individuals; resulting in some common risk reduction benefit.



CHECK YOUR PROGRESS

Q.5: State whether true or false:

i. Land use planning is an example of non-structural mitigation measures

ii. Denial of services to high-risk areas is a regulatory measure in risk reduction.

iii. Building code is a structural mitigation method.



8.6 LET US SUM UP

- Disaster risk reduction limits negative impact of any hazard on those who stand to lose the most.

- DRR requires a people-centred and multi-sector approach, building resilience to multiple, cascading and interacting hazards.
- The Hyogo Framework for Action was a 10-year plan (2005-2015) at the World Conference on Disaster Reduction to make the world safer from natural hazards.
- The Sendai framework 2015-2030 outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks.
- National Disaster Management Plan is a comprehensive plan in India to make the country disaster resilient and to minimize the effects of damages from disasters.
- Mitigation is defined as any sustained effort undertaken to reduce a hazard risk through the reduction of the likelihood and/or the consequence component of that hazard's risk.
- Structural mitigation measures are any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques to achieve hazard resistance and resilience in structures or systems.
- Non-structural measures use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education.
- Common non-structural measures include building codes, land-use planning laws and their enforcement, research and assessment, information resources and public awareness programmes.



8.7 FURTHER READINGS

- Natural Disasters by P. L. Abbott, McGraw Hill (Higher Education) New York, 2004.

- *Disaster Response and Recovery* by David A McEntire, WILLEY, 2007.
- https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030



8.8 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1: Disaster risk reduction is a systematic approach to identifying, assessing and reducing the risk of disaster

Ans. to Q. No. 2: The Sendai framework aims to achieve the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

Ans. to Q. No. 3: Dams, flood levies, ocean wave barriers, earthquake-resistant construction and evacuation shelters are examples of structural mitigation measures.

Ans. to Q. No. 4: Engineers can develop building codes that guide builders to ensure that their designs are able to resist the forces of the relevant hazards.

Ans. to Q. No. 5:

i. True
ii. True
iii. False



8.9 MODEL QUESTIONS

Q.1: What is risk in a disaster?

Q.2: What is the importance of disaster risk reduction?

Q.3: What was the objectives of Hyogo Framework?

Q.4: When was Sendai Framework adopted?

Q.5: How many targets and priority actions are contained in the Sendai Framework?

Q.6: What are the advantages of Sendai Framework?

Q.7: Give examples of structural mitigation measures.

Q.8: What are the differences between structural mitigation and non-structural mitigation?

Q.9: Mention a few common non structural mitigation methods.

Q.10: Write about India's initiative in disaster risk reduction.

*** *** ***