ANNAMACHARYA UNIVERSITY

EXCELLENCE IN EDUCATION; SERVICE TO SOCIETY

ESTD, UNDER AP PRIVATE UNIVERSITIES (ESTABLISHMENT AND REGULATION) ACT, 2016)

Rajampet, Annamayya District, A.P – 516126, INDIA

CIVIL ENGINEERING

Lecture Notes

on

DISASTER MANAGEMENT

Written by

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Civil Engineering

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CIVIL ENGINEERING

Disaster Management

UNIT-1

DISASTER MANAGEMENT

Lecture Notes

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Introduction to disasters and Natural Disasters

UNIT-I – Definitions of Risk, Vulnerability and Disasters and their Relationship; classification of Disasters; Natural disasters; Environmental and Weather pre-conditions leading to various Natural Disasters; Floods; Urban Floods; Flash Floods; Cyclones; Earthquakes; Landslides; Avalanches; Mudslides impacts of Natural Disasters; Important case studies (2006 Tsunami, covid 19 e.t.c.,)

Introduction

* The World is becoming increasingly Vulnerable to natural disasters. Nearly 3 Million people worldwide may have been killed in Past of 20 years due to Natural disasters.
* Ninety percent of the Natural disaster and 95% of the total disaster related deaths worldwide occur in developing countries in which India has the second Largest share.
* Innovation is science and Technology for disaster risk reduction is one of the Key challanges for Transdisciplinary future Earth research towards promoting global Sustainability.
* 29 September is celebrated as the Foundation day of the NDMA.
* The GOI, In recognigation of the importance of disaster Management as a National priority, set-up a High-Powered committee (HPC) in Aug, 1999. and a National committee after the Gujarat Earthquake.

Disaster Scenerio of India

→ India is amogest the klorld's MOst disaster prone areas (85% of Geographical area)

→ 26 out of 36 states are affected by frequent disasters.

→ 58.6% land Vulnarable to Earthquake

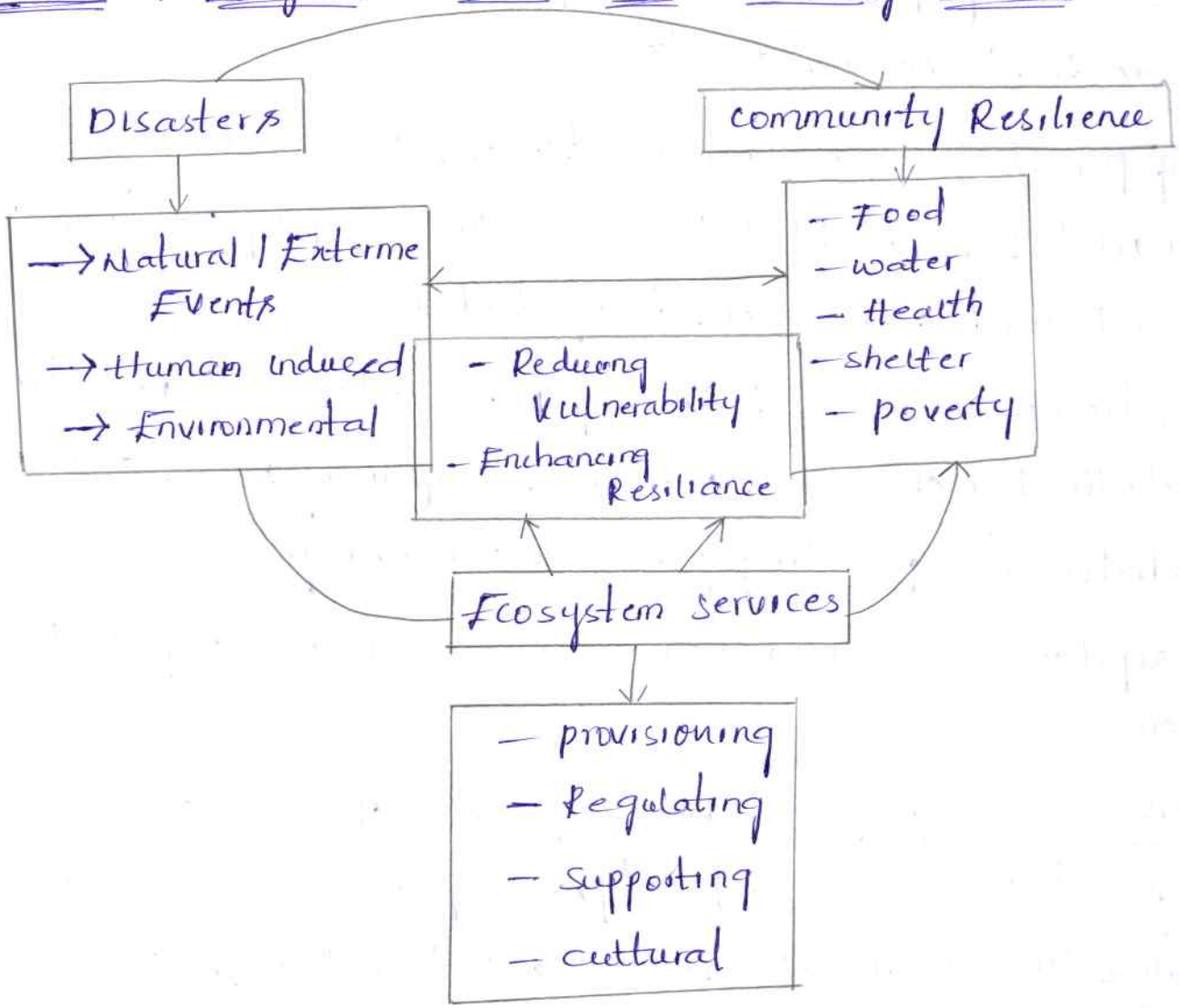
→ 68% of cultivable area is prone to drought

→ 8.5% land Vulnerable to cyclones - 570 Kms out of 7516 Kms of coastline.

→ 12% land Vulnerable to floods in the Indo-gangetic Brahmputra plains

→ 15% area is prone to landslides

Disaster, Ecosystem Services and community Resilience



Definitions of Risk, Vulnerability and Disasters and their Relationship:

- Risk: The potential for loss of life, injury or damaged assets, which could occur to a system, society, or community over a specific future period.
- Formula:
  Disaster Risk = Hazard X Vulnerability X Exposure
- Vulnerability: The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard, Factors include poverty, poor infrastructure, lack of early warning systems, and social inequality.
- Relationship: A Hazard (e.g., a cyclone) only becomes a disaster when it interacts with a vulnerable and Exposed population or areas, creating a significant Risk of loss.

Classification of Disasters

Natural disasters

Natural disasters are often classified based on their origin:

Classification	origin/Force	Example
Geophysical	Earth's internal processes/ Crustal Movement	Earthquakes, Tsunamis Volcanic Eruptions, Landslides
Hydrological	Water-related processes	Floods, Flash Floods, Avalanches.
Metrological	Short-lived atmospheric conditions/ patterns	Tropical cyclones (Hurricans/ Typhoons), Tornadoes, Hailstorms

Climatological	long-lived atmospheric conditions/patterns	Droughts; Heat Waves, Wildfires.
Biological	Spread of infectious agents	Epidemics pandemics (Eg., COVID-19)

Environmental and Weather pre-conditions leading to various Natural disasters:

- Climate change: A primary pre-condition increasing the Frequency and intensity of weather-related disasters.
  - Rising Global Temperatures: Leads to more intense heat waves and droughts
  - Increased Water Vapor in Atmosphere: Fuels more powerful storms and heavy precipitation events (leading to floods / cyclones)
  - Sea level Rise: Exposes coastal areas to greater flood and Storm surge risks.
- Environmental degradation: Deforestation destabilizes slopes (increasing Landslides/Mudslides). poor urban planning and concretization reduce water infiltration (increasing urban floods).

Specific Disaster types:

1. Floods
2. Cyclones
3. Earthquakes, e.t.c.,

- Floods: overflow of a large amount of water onto land that is usually dry.
  - Urban Floods: occur in cities due to poor drainage/sewage systems and high
  - Flash Floods: Rapid onset and rise of water levels, typically caused by intense, localized heavy rainfall.
- cyclones (Hurricanes/Typhoons): Large-scale rotating wind systems forming over warm ocean waters, characterized by strong winds, heavy rain and storm surges.
- Earthquakes: Sudden shaking of the Earth's surface caused by the Rapid release of energy on the Earth's crust, usually due to movement along fault lines (tectonic plates)
- Landslides/Mudslides: Downward movement of a mass of rock, debris, or earth down a slope, often triggered by saturated soil from heavy rainfall or seismic activity.
- Avalanches: A rapid flow of snow down a sloping surface, often triggered by Natural causes (snowpack weakening) or extrnal forces (Human activity, earthquakes).

Impacts of Natural Disasters

Dimension	Key impacts
Human & Social	loss of life, injuries displacement, Psychological trauma (PTSD), breakdown of

	Social structures, forced Migration.
Economic	Destruction of critical infrastructure (roads, power grids), disruption of businesses, loss of crops/livestock, decline in GDP, increased national debt due to reconstruction costs
Environmental	Destruction of ecosystems (forests, wetlands), soil erosion (loss of fertile topsoil), pollution of water sources (sewage, debris), loss of biodiversity.

Importance of case studies (2004 Tsunami, COVID-19 e.t.c.)

- 2004 Indian Ocean Tsunami:
  - cause: A Massive Megathrust Earthquake ($M \approx 9.1-9.3$) off the west coast of Sumatra, Indonesia, on December 26, 2004
  - impact: Generated catastrophic waves that affected 14 countries, killing over 230,000 people. one of the deadliest Natural disasters in recorded history.
  - Lesson: Led to the establishment of the Indian Ocean Tsunami Warning and Mitigation System (IOTWMS)

- COVID-19 Pandemic (2020 - present):
  - Nature: A Biological Disaster caused by the SARS-CoV-2 virus
  - Impact: Global health crisis, Massive death toll, severe economic recession due to lockdowns, disruption of global supply chains, strain on healthcare systems worldwide.
  - Lesson: Highlighted the need for global cooperation, robust public health infrastructure, and preparedness for biological hazard.

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CIVIL ENGINEERING

Disaster Management

UNIT-2

Manmade Disaster

UNIT-2 – classification of ManMade Disaster : Accidents, Industrial Mishaps ; wars - Military, Bio-war and cyber Warfare ; Nuclear Disaster ; Blackouts ; cyber Attacks, oil spills, compound or cascading Disaster ; preconditions various Manmade Disasters ; impacts of Manmade Disasters ; important case studies (Bhopal Gas Tragedy, Fukushima Disaster, Encore oil spill, Vizag strene Leak).

Manmade Disaster :

A manmade disaster is an emergency situation or catastrophe where the principal direct causes are identifible human actions or inaction, involving a failure of a human-made system or structure

1. classification of manMade Disasters

Manmade disasters can be classified based on their source and Nature :

classification	Definition
Accidents	unintentional events resulting in damage, loss of life, or environmental contamination
Industrial Mishaps	Failures or Explosions in industrial processes, leading to the release of hazardous substances.
Wars - Military	organized, deliberate armed conflicts between states or groups.

Bio-war (Biological Warfare)	Intentional use of pathogenic organisms (bacteria, viruses, fungi) or toxins to cause widespread disease and death
cyber warfare / cyber Attacks	Attacks on critical infrastructure, government, or financial systems using computer networks, leading to disruption or failure.
Nuclear disaster	Catastrophic events involving nuclear power plants or nuclear weapons, resulting in the release of harmful radiation
Blackouts	Widespread, long-duration loss of electricity, often resulting from grid failure, equipment malfunction, or successful cyber Attack
Oil spills	uncontrolled release of crude oil or refined petroleum products into the environment, especially marine ecosystem.
Compound or cascading Disaster	A primary disaster (often Manmade or natural) triggers a secondary usually technological, disaster

2. Preconditions (Causes) of Various Manmade Disasters

Manmade disasters are complex, resulting from an accumulation of failure rather than a single event.

A. Technological & Industrial Disasters:

- Human error: Operator fatigue, poor decision-making, ignoring alarms, or failure to follow standard operating procedures (SOPs)
- Organizational / Management Failure: underinvestment in Maintenance, reduction in skilled staff, low employee morale, and lack of a strong safety culture.
- Design Flaws: Equipment or system design that fails to account for worst-case scenerios, or lack of redudancy in critical safety systems.
- Inadequate Regulations: Lax government enforcement of safety and Environmental standards or outdated industrial laws.
- Poor Maintenance: Deffered repairs, using sub-standard parts, and ignoring warning signs (near-misses)

B. Wars & Socio-political Disasters

- Political / Ideological conflict: Disputes over territory, governance, or ethnic / religious identity.
- Resource Scarcity: competition for essential resource like water or arable land.
- Global Instability: intervention by external state or non-state actors creates new avenues for conflict through cyber attack.

Compound / cascading Disasters

- Lack of Disaster - Resistant Hardening : Failure to fortify critical Manmade structures (factories, Nuclear plants, oil pipelines) against known Natural Hazards (Earthquakes, tsunamis, floods)
- Interdependency Failure : The failure of one system (e.g., power) causes the total failure of a dependent system (e.g., cooling pumps at a Nuclear plant)

Impacts of Manmade disasters

The impacts are Multi dimensional, often having deeper socio-economic and physiological effects than Natural disasters.

Impact category	Specific Effects
Human & Health	Mortality and Morbidity : immediate deaths, long term physical illness (cancer, respiratory, neurological damage) due to Exposure to toxins or radiation. Mental Health : Severe psychological trauma, anxiety, and post-Traumatic stress disorder (PTPD) among survivors and responders

Economic	property Damage: Destruction of homes, commercial buildings, and infrastructure. Bussiness disruption: Factory closures, loss of employment and livelihoods, and significant economic burden from long-term medical care, Trade Impact: loss of bussiness confidence and damage to international reputation.
Environmental	Toxicity: Widespread contamination of soil, water bodies, and air with hazardous substances, rendering areas uninhabitable or infertile, Ecosystem loss: Devastation of Marine life (oil spills), deforestation, and disruption of food chains.
Socio-political	Mass displacement: Creation of internal refugees and long-term settlement issues. Erosion of Trust: loss of public confidence in the government, cooperate Management, and regularoty

	bodies. Legal Battles: protracted litigation for compensation and criminal proceedings against negligent parties.

Important case studies:

A. Bhopal Gas Tragedy (December 3, 1984)

- Disaster Type: Industrial Mishap (Chemical Gas Leak)
- Incident: over 40 tons of highly toxic Methyl Isocyanate (MIC) gas leaked from the Union Carbide India Limited (UCIL) pesticide plant.
- Key cause: poor operating procedures, deferred Maintaince, Safety systems being shut down to save Money, and failure of Multiple safety Mechanism. A Large volume of water entered the MIC storage tank, triggering a runaway reaction.
- Impact: immediate death of thousands (official and unofficial figures vary significantly), and Widespread, debilitating long-term illnesses for over 5000,000 survivors, leaving a legacy of chronic health issues and contaminated ground Water.

B. Fukushima Disaster (March 11, 2011)

1. Disaster Type: Nuclear Disaster (Cascading Failure)
- Incident: A Massive M9.1 earthquake and subsequent tsunami disabled the cooling systems at the Fukushima Daiichi Nuclear power plant.

- Key cause: The Earthquake caused the initial shutdown, but the Massive tsunami that followed excedded the plant's design specifications, flooding the lower levels and disabling the backup diesel generators that powered the cooling pumps. This lead to Nuclear Meltdowns in three reactors and the release of radiation.
- Impact: Massive release of radiation into the atmosphere and Ocean, forced long-term evacuation of over 100,000 residents from the contaminated zone, and significant long-term costs for cleanup and decommissioning.

C. Ennore oil spill (January 28, 2017)

- DisasterType: oil spill (Transportation / Marine Accident)
- Incident: Two ships, M.T. Dawn Kanchipuram and B.K. Maple collided near Kamarajar port (Ennore), chennai, resulting in a large oil spill.
- Key cause: Human Error in navigating the ships and failure to follow Maritime rules and protocols during an unladen ship's departure.
- Impact: severe pollution of the chennai coastline, loss of Marine life (fish, turtles, e.t.c.)) and Crippling of the livelihoods of thousands of local fisherfolk. The cleanup process was extensive and slow.

5. Vizag Styrene Leak (May 7, 2020)

- Disaster type: Industrial Mishap (Toxic Gas leak).
- Incident: Styrene vapour leaked from a storage tank at LG polymers in Visakhapatnam (Vizag) while the plant was shut down during the COVID-19 Lockdown.
- Key cause: The storage tank temperature rose unexpectedly due to poor operational Management during the Lockdown. Styrene is supposed to be stored at low temperatures (below 20°C) the temperature increase triggered auto-polymerization of the styrene, causing a massive pressure buildup and leakage of toxic vapor.
- Impact: Immediate death of 12 people, hundreds hospitalized, significant damage to crops, and loss of livestock in surrounding villages. The Leak highlighted the critical need of safety protocol adherence even during plant shutdowns.

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CIVIL ENGINEERING

Disaster Management

UNIT-3

Unit-III - Definition, scope and Methods of - Crisis Management, Emergency Management, importance of emergency Management, Evacuation plans; Mock drills of evacuation, Industrial safety drills; monitoring of hazardous components in industries and places of public importance.

Introduction:

A Man-Made disaster (or human-induced disaster/hazard) is a catastrophe or grave occurance caused by human action or inaction, negligence, error, or a failure of a man-made system. Un like natural disasters, these events are preventable and are fundamental rooted in technological failure, industrial processes, improper management or deliberate hostile acts.

Key Characteristics:

- preventable: They often stem from a failure to follow safety protocols, regulatory lapses, or a deliberate choice.
- Varying onset: can be sudden (e.g., a gas leak explosion) or continuing/slow-onset (e.g., long-term pollution, environmental degradation)
- Diverse scope: Range from localized industrial accidents to large-scale international conflicts and global environmental crises.

Classification of Man-Made disasters :

Man-Made disasters can be broadly categorized into several types based on their cause and Nature.

A. Technological and industrial Disasters :

These result from failures in industrial infrastructure, hazardous Material handlings, or power generation system.

Type	description
Industrial Accidents	uncontrolled releases, explosions, or fires at industrial or chemical plants. often involve highly toxic or flammable materials
Nuclear / Radiological	Accidents involving Nuclear power plants, release of radioactive Material, or detonation of Nuclear devices
oil and chemical spills	Release of hazardous liquids into the environment, typically affecting water bodies and ecosystems.
infrastructural Failure	collapse of human-made structures due to poor design, Maintenance, or Material failure

Blackouts/power failures	Large-scale loss of power that cripples essential services and can lead to cascading failures.

(10)

B. Socio-political Disasters

These are intentional acts of violence, conflict, or social disorder

Type	Description	Example
War and conflict	Fully-fledged armed hostilities between states or domestic upheavals. causes massive loss of life displacement, and economic destruction	World wars, civil wars, and territorial conflicts
Terrorism	Unlawful use of violence or intimidation against civilians to achieve political or ideological aims	9/11 attacks, serial bomb blasts
Civil/communal Riots	Large-scale violent disturbances within a community	Communal clashes leading to stampedes, arson, and localized destruction.

C. Accident-Related Disaster:

These are related to human error, negligence, or mechanical failure during transport or operations.

Type	description
Transportation Accidents	Major accidents involving mass transit systems (road, rail, air, sea)

Forest/Urban Fires	Large fires caused by human carelessness or arson, not natural causes.

D. Hybrid Disasters

These are events where a natural hazard interacts with and causes a failure in a man-made system, leading to a disaster

Type	Description	Examples
Natural triggered	An Earthquake, flood or hurricane damages a critical facility (e.g., chemical plant, refinery), causing a subsequent technological disaster	Fukushima Disaster (Earthquake/Tsunami damaged Nuclear plant).

Causes and preconditions:

Man-Made disasters rarely have a single cause. They often result from an "incubation period" where multiple failures accumulate unnoticed within a complex system.

A. Human Factors

- Human Error / Negligence: Mistake in operation, maintenance, supervision, or emergency response.
- Lack of Training: personal not adequately trained for routine tasks or emergency scenarios.
- Complacency: A false sense of security in a technologically advanced system, leading to the ignoring of minor warning signs.

- Intentional Acts: Sabotage, arson, terrorism, or declarations of war.

B. Technical and Systemic Failures:

- Equipment Failure: Malfunctions due to design flaws, manufacturing defects, or wear and tear (e.g., corroded pipes, faulty cooling systems).
- Inadequate Safety Systems: Non-functional, poorly maintained, or insufficient backup safety measures (e.g., a non-operational flare tower during a gas leak)
- Insufficient Maintenance: Neglect of critical systems over time to cut costs or due to operational oversight.

C. Regulatory and Socio-Economic preconditions

- Regulatory Failure: Inability of laws and regulations to keep pace with industrial development, or a failure to enforce existing safety standards.
- Poor Land use planning: Allowing human settlements to encroach near high-hazard industrial zones.
- Economic pressures: prioritizing profit over safety, leading to cost-cutting measures that compromise essential safety protocols.
- Political Instability: Long-standing strife or domestic upheavals that culminate in armed conflict or war.

Major Impacts

The consequences of Man-Made disasters are extensive, often resulting in long-term damage to human life, the economy,

and the environment.

A. Human and Health Impacts

- Mass casualties : immediate loss of life and severe physical injuries.
- Long-Term Morbidity : Chronic diseases (e.g., cancer, respiratory, reproductive issues) due to exposure to toxic chemicals or radiation.
- psychological Trauma : Increased fear, anxiety, post-traumatic stress disorder (PTSD), and overall disruption of community mental health.

B. Environmental Damage

- Pollution and contamination : Massive release of toxins into air, water, and soil, contaminating natural resources and agricultural land.
- Ecosystem Damage : Destruction of marine life, forests and other ecosystems (e.g., through oil spills or chemical run off)
- Environmental degradation : Long-term soil degradation and depletion of groundwater resources.

C. Economic and social Impacts

- property and Infrastructure Damage : Destruction of homes, business, public utilities, and critical infrastructure.
- Economic losses : Lost productivity, business closures, increased insurance costs, and billions in clean-up and compensation expenses.

- Disruption of services: interruption of critical supplies like water, electricity, and transportation.
- Displacement: Forced evacuation and long-term homelessness for affected populations.
- Loss of cultural Heritage: Destruction of historical sites during conflicts or fires.

Case studies of Man-made disasters

A. Bhopal Gas Tragedy (India, 1984)

- Type: Industrial Accident (chemical Disaster)
- Event: on the night of December 2-3, 1984, over 40 tons of Methyl Isocyanate (MIC) gas leaked from the Union Carbide India Limited (UCIL) pesticide plant in Bhopal)
- Cause: Water entered a storage tank containing MIC, triggering a runaway reaction that increased temperature and pressure, causing the toxic gas to vent into the atmosphere. Key factors included non-functional safety systems (flare tower, vent gas Scrubber) and poor safety Maintenance.
- Impact: Considered the World's worst industrial disaster. official immediate death toll of 2,259. With total estimated deaths over the years reaching 25,000 according to activists. over 500,000 people were exposed, resulting in severe and permanent injuries, chronic health problems, and long-term soil and water contamination.

B. Visakhapatnam (Vizag) Gas leak (India, 2020)

- Type: Industrial Accident (chemical disaster)
- Event: on may 7, 2020, styrene vapor leaked from an LG polymers chemical plant in R.R Venkatapuram, Visakhapatnam
- Cause: Malfunction in the cooling system of the styrene storage tanks and improper storage; the tanks had been left unattended during the COVID-19 lockdown, allowing the temperature to rise and trigger the polymerization and subsequent vapor release.
- Impact: caused 13 deaths and over 1,000 non-fatal injuries. Hundrends were hopitalized with breathing difficulties, burning eyes, and unconsciousness. Fumes spread over a radius of around 3 km, necessitating the evacuation of nearby villages.

C. Fukushima Daiichi Nuclear Disaster (Japan, 2011) - Hybrid disaster

- Type: Nuclear Disaster (Triggered by Natural Disaster)
- Event: on March 11, 2011, a magnitude 9.0 earthquake and subsequent tsunami struck Japan, leading to core meltdowns and release of radioactive Materials at the Fukushima Daiichi Nuclear point plant.
- Cause: The Earthquake and tsunami destroyed the external power supply and the backup generators, leading to the failure of the cooling systems for the nuclear reactors. This technological failure, following the Natural trigger, caused an uncontrolled heat increase.

- Impact: classified as a level 7 event (the highest severity, same as chemobyl). caused mass evacuation and long-term contamination of large areas. While there were no immediate deaths directly attributed to the radiation, the clean up and displacement costs were astronomical, and long-term health monitoring for the exposed population remains a major concern.

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Disaster Management

UNIT-4

Disaster Risk Reduction

UNIT-4 : Global and National disaster trends, common Disaster in India, risk analysis, Vulnerability and capacity assessment; early warning systems, Disaster Management cycle - its phases; prevention, Mitigation, preparadness, relief and recovery; structural and non structural safety and rehabilition Measures; post-disaster environmental response (water, sanitation, food safety, Waste Management, disease control); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programs in India and the activities of National Disaster Management Authority.

1. Foundation of Disaster Risk Reduction (DRR)

Core concepts : Hazard, Vulnerability, Risk, and capacity

Concept	Definition	Analysis component
Hazard	A dangerous pheromenon, Substance, human activity, or condition that may cause loss of life, injury, Property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (e.g., Earthquake, cyclone, industrial Accident)	Risk is proportional to the presence and intensity of a hazard.

Vulnerability	The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard. Factors include poverty, kleak infrastructure, lack of awareness, and kleak goverenue.	Risk of proportional to Vulnerability
capacity	The combination of all the strengths and resources available within a community, society, or organization that can reduce the level of risk or the effects of a disaster (e.g., well-trained emergency services, community awareness strong local economy)	Risk is inversely proportional to capacity
Disaster Risk (R)	The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society, or community over a specified period of time	Risk $= \frac{\text{Hazard} \times \text{Vulnerability}}{\text{capacity}}$

Global and National Disaster Trends

- Global Trends: Increased frequency and intensity of hydro-meteorological hazards (floods, droughts, storms) due to climate change. Rapid urbanisation in high-risk zones and rising global population increase exposure and vulnerability, leading to greater economic losses.
- Indian context (Vulnerability profile): India is one of the most disaster-prone countries due to its diverse geography and socio-economic factors:
  - Earthquakes: 58% of Land Mass is prone to Moderate-to very high-intensity earthquakes (Himalayan belt, Indo-Gangetic plain).
  - Floods: over 40 Million hectares are flood-prone (Ganga-Brahmaputra basin).
  - Cyclones and Tsunamis: 5,700 KM of the coastline is prone to cyclones (Bay of Bengal and Arabian Sea).
  - Droughts: 68% of the cultivable area is Vulnerable to drought
  - Man-Made Hazards: High Vulnerability to industrial, Chemical, and infrastructure accidents due to rapid industrialisation.

Disaster Management cycle and phases

The Disaster Management cycle is a continuous process comprising phases aimed at reducing disaster impact and facilitating effective recovery.

Phase	Focus / Goal
1. Prevention & Mitigation (pre-Disaster)	Actions taken to reduce or avoid the undesirable consequences of hazards
2. Preparedness (pre-Disaster)	Actions taken to prepare for an effective response.
3. Response (During) Disaster	Actions taken immediately before, during or immediately after a disaster to save lives, protect property, and the environment
4. Recovery (post-Disaster)	Action taken to restore the affected area to its previous or a new, safer normal.

Structural and Non-structural safety Measures:

Type	Definition
Structural Measures	physical construction or engineering works to mitigate hazard impact.
Non-structural Measures	Non-physical Measures like policies, laws, education, and institutional Mechanisms to reduce risk.

Early Warning systems (EWS)

An EWS is an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication, and preparedness activities.

- Four elements of a complete EWS:

1. Risk knowledge: Knowing the hazards and Vulnerabilities (Risk Analysis).
2. Monitoring & Forecasting: Having a Technical and scientific basis for predicting the event (e.g., India Meterological Department for cyclones)
3. Dissemination and communication: Sending timely, clear, and relevant Warnings to all those at risk (using different Media: Tv, radio, Mobile alerts, Sirens)
4. Response capability: Having an action plan for the community and authorities to follow upon receiving the Warning.

Post-Disaster Environmental Response:

Immediate and effective environmental response is crucial to prevent secondary disasters (like epidemics).

- Water safety: Restoring potable Water supply, treating contaminated sources, and distributing Water purification tablets.

- Sanitation: Setting up Emergency sanitation facilities (temporary toilets), cleaning sewage lines, and preventing contamination of groundwater.
- Food safety: Ensuring the provision of uncontaminated food, Monitoring food distribution centres, and preventing food spoilage.
- Waste Management: Immediate clearance of debris (structural and Non-structural), establishing temporary disposal sites, and Managing hazardous waste and carcasses to prevent disease.
- Disease control: Surveillance for potential epidemics (e.g., cholera, dengue), Mass vaccination where necessary, and Vector control (Mosquitoes, rodents)

Institutional and Legislative Framework in India

Policies and Legislation:

1. Disaster Management Act, 2005: The legislative foundation for DM in India. It Mandated a paradigm shift from a relief-centric approach to a holistic, proactive, Multi-disaster, and technology-driven strategy focusing on prevention, Mitigation, and preparedness.
2. National policy on Disaster Management (NPDM), 2009: Aims to build a safe and disaster-resilient India by development and enforcing a culture of prevention, preparedness,

for effective response and to "Build Back Better".

2. Institutional structure (Hierarchical)

- National Disaster Management Authority (NDMA): Apex body for DM, headed by the prime Minister. Responsible for laying down policies, plans and guidlines for D.M.
- National Executive committee (NEC): Headed by the union Home Secretary, responsible for implementing the National plan and acting as the coordinating body for response.
- State Disaster Management Authority (SDMA): Headed by the chief minister. It lays down state DM policies and plans.
- District Disaster Management Authority (DDMA): Headed by the district collector / Magistrate, responsible for planning and implementation at the local level.
- National disaster Response Force (NDRF): A Specialised humanitarian task force for disaster response, based on the principle of prompt and professional deployment.

Roles and Responsibilites of stakeholders:

Stakeholder	Key Roles and Responsibilites
Government (Central/ State)	Policy formulation, resource Mobilisation, creation of institutional framework (NDMA, SDMA), funding, Training, and deployment

	of specialised forces (NDRF, SDRF)
Community & Local Institutions (PRIs/ULBs)	Crucial as first responders Developing community-Based Disaster Management (CBDM) Plans, local risk assessment, Maintaining traditional Knowledge, organising Volunteers, and participating in Mock drills.
NGOs and civil Society	Relief operations, providing specialised aid (counselling, Medical), advocacy for vulnerable groups, linking government aid to the affected, and capacity building at the grassroots level
Private sector	implementing safety standards (Business continuity planning), providing logistical support, financial resources, Expertise in reconstruction and promoting disaster insurance.

Community-Based disaster Risk Reduction (CBDRR):

CBDRR focuses on empowering local communities to understand their own risks and implement their own, locally-appropriate solutions. It recognises the community as the first responder and the most knowledgeable stakeholder regarding local vulnerabilities and capacities.

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Disaster Management

UNIT-5

Aftermath Disaster

UNIT-5 : post Disaster Situations ; Rebuilding - Methods and Strategies ; Re-development - Methods and strategies ; Environmental design ; Disaster resistant design in built environment and in industries . change in Land use pattern and its effects on human settlements . capacity building of the society and the industries against disasters .

Disaster Risk Reduction (DRR)

1. Global and National Disaster Trends & common Disasters in India.

Aspect	Global Trends	National Trends (India)	common disaster in India
Trends	Increasing frequency and intensity of hydro-meteorological hazards (floods, droughts, storms) due to climate change. Rising Vulnerability from rapid urbanization and population growth in hazard prone areas	High vulnerability profile : 58% of land is earthquake-prone, 12% is flood prone, and over 68% is drought-prone Economic losses are significant and are increasingly affecting the Indian Middle class	Natural : Earthquakes (Himalayan belt), Floods (Ganga-Brahmaputra basin), cyclones (Coastal states), droughts (Peninsular India), Landslides.

Risk Analysis, Vulnerability and capacity Assessment (VCA)

The fundamental equation for Disaster Risk is : Risk

$$\approx \frac{\text{Hazard} \times \text{Vulnerability}}{\text{capacity}}$$

- Risk Analysis: The process of estimating the potential losses (lives, property, economy) that could result from a specific hazard. It involves:
- Hazard Assessment: Determining the potential intensity, frequency, and spatial Extent for a hazard.
- Exposure Assessment: identifying the elements (people, infrastructure, assets) located in hazard zone.
- Vulnerability Assessment: Determining the susceptibility of a community or system to damage. It's Multi-dimensional:
  - Physical: Quality of housing, locating of infrastructure.
  - Social: Age, gender, disability, social exclusion, lack of education.
  - Economic: poverty, low, income, lack of savings or insurance.
- Capacity Assessment: identifying the resources, strengths, and abilities with in a community that can be used to cope with or resist a disaster. This includes:
  - Physical: Well-Maintained infrastructure, emergency equipment.
  - Social: Strong community organization, traditional knowledge.
  - Institutional: Effective local governance, trained personnel.

Early Warning Systems (EWSs):

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A complete and effective EWS requires four interconnected elements:

1. Risk Knowledge: Systematically collecting data and conducting risk assessment (Hazard + Vulnerability)
2. Monitoring and Forecasting: Developing scientific and technological systems to monitor and predict hazard events (e.g., IMD for cyclones).
3. Dissemination and communication: Ensuring timely, clear and actionable warnings reach all people at risk, using multiple channels (sirens, TV, radio, mobile alerts).
4. Response capability: Having community-level and official plans detailing what do when a warning is received (evacuation routes, shelter management).

Disaster Management cycle - phases

The DM cycle is a continous process divided into three main stages: pre-disaster During, and post-disaster.

Phase	Main Goal	Key Activities
prevention	Avoid the creation of new risks	Long-term measures like permanent land-use zoning, construction of large-scale protective works (dams, embankments

Mitigation	Reduce the negative effective of unavoidable hazards	Structural - Retrofitting old buildings, developing robust infrastructure. Non-structural: enforcing building codes, public awareness campaigns
Preparedness	Ensure readiness to respond when a disaster strikes	Developing Disaster Management plans (DMPs) stocking essential supplies, conducting mock drills, training emergency teams
Response	Immediate action to save lives and meet basic needs	Search and Rescue (S&R) providing first-Aid, emergency Medical Care, setting up temporary shelter and food camps
Recovery	Long-term restoration of livelihoods, infrastructure and services.	Rehabilitation (short-term restoration) and Reconstruction (long-term rebuilding, guided by Build Back Better).

Structural and Non structural safety and Rehabilitation Measures

- Structural Safety Measures: physical construction or engineering efforts to make structures hazard-resistant.
  - Examples: Constructing earthquake-resistant buildings (using seismic design codes), building cyclone / flood shelters, reinforcement bridges and critical infrastructure (hospitals, schools).

- Non-structural safety Measures: policies, practices, laws, and public education to reduce risk.
  - Examples: Enforcing zoning regulations (no building in high risk flood plains), public awareness and education programs, creating disaster insurance Markets.
- Rehabilitation Measures: Actions to help communities return to normal functioning in the post-disaster phase.
  - Examples: providing financial aid for temporary housing, restoring water and power supply, and psychological Counseling services.

Post Disaster Environmental Response (water, sanitation, food Safety, Waste Management, Disease control)

A critical immediate response to prevent a secondary disaster (epidemics)

- Water safety: Restoring safe drinking water supply, disinfecting contaminated sources, and distributing Water purification tablets.
- Sanitation: Establishing Emergency sanitation facilities (temporary toilets), cleaning damaged Sewage lines, and preventing Water Source contamination.
- Food safety: Rapid inspection of food stocks, ensuring safe preparation and distribution of relief food, and Monitoring food distribution points for hygiene.

- Waste Management: immediate collection and disposal of debris (rubble, waste from damaged infrastructure) and carcasses to prevent decay and breeding of vectors.
- Disease control: Surveillance for potential outbreaks of water-borne disease (cholera, typhoid) and vector-borne disease (dengue, Malaria), and setting up mobile health units for mass vaccination / treatment.

AfterMath Disaster

1. post-Disaster situations and Rebuilding Methods:

The post-disaster phase is defined by chaos and immediate needs, transitioning into long-term planned recovery.

- post-disaster situations:
  - chaos and Trauma: Loss of life, injury, psychological trauma, breakdown of law and order.
  - Infrastructure collapse: Disruption of lifelines (power, water, communication, roads)
  - Economic disruption: Loss of livelihood, damage to small business and agricultural land.
  - Mass Displacement: Need for temporary shelter and basic relief.
- Rebuilding Methods and strategies: The core strategy is "Build Back Better" (BBB)
  - Assement: conducting comprehensive Damage and Loss Assessment (DALA) to determine the required scope of

Recovery.

- Phased Approach: Moving systematically from Relief → Rehabilitation → Reconstruction.

- Inclusivity: Ensuring the needs of the most vulnerable (Women, children, disabled) are met during rebuilding.

Re-development, Disaster-Resistant Design, and Environmental Aspects

- Re-development: The process of planned, long-term economic and social recovery. This often involves:
  - Restoring livelihoods: Providing vocational training, soft loans, and grants to re-establish economic activities.
  - Social Restoration: Reopening schools, restoring healthcare services, and psychosocial support.
- Disaster-Resistant Design and Environment-Resilient solutions:
  - Disaster-Resistant Design: Mandating and enforcing the highest level of structural safety codes in reconstruction (e.g., using better Materials, seismic retrofitting, Wind-proofing).
  - Environment-Resilient Solutions: integrating ecosystem restoring into rebuilding.

  Examples: Replanting coastal Mangroves for protection against storm surge, implementing Watershed Management to reduce flood risk.

- Changes in Land-use pattern and its Effects on Human Settlements:
  - post-disaster recovery is an opportunity for risk-informed land use planning.
  - Strategy: Restricting rebuilding on the most hazardous zones and promoting safe relocation of vulnerable settlements to safer areas.
  - Effect: Reduce future Exposure and Enchances the long-term safety of human-settlements through it requires sensitive Management of Land rights and community consent.

Capacity Building of society and industries Against Disasters

Capacity building is essential for transitioning form a victim Mentality to a culture of sentience.

- capacity Building for society (Communities):
  - Education and Awareness: integrating DRR topics into School curricula and community training.
  - Training: Training local volunteers in first aid, search and rescue, and shelter Management (Community Emergency Response Teams - CERTs).
  - Developing Resilience: Fostering strong social capital and community networks to ensure mutual support during crises.

- Capacity Building for industries :
  - Bussiness continuity planning (BCP) : Training industries to develop plans to continue essential functions during and after a disaster.
  - Disaster insurance : Encouraging industries to opt for comprehensive disaster and business interruption insurance to mitigate financial shock.
  - Hazard-proofing : Requiring industries, especially chemical and nuclear plants to implement rigorous safety and hazard-proofing Measures (NATECH disaster prevention).