

LO Syllabus and PYQ

21 January 2025 02:14 AM

SYLLABUS	<ul style="list-style-type: none">• Question : 10-25 Marks• Disaster and Disaster Management<ul style="list-style-type: none">• Introduction• Types of Disasters & Vulnerability profile of India• Disaster Management Cycle• Hyogo and Sendai Framework• Disaster Management in India• Disaster Management Act of 2005• DM Architecture and Institutions• Case Studies of recent disasters• NDMA Website : Disaster related data
PYQ	<p>Q.1) Dam failures are always catastrophic, especially on the downstream side, resulting in a colossal loss of life and property. Analyse the various causes of dam failures. Give two examples of large dam failures. [150 Words] [10 Marks] [2023]</p> <p>Q.2) Explain the mechanism and occurrence of cloudburst in the context of the Indian subcontinent. Discuss two recent examples. [150 Words] [10 Marks] [2022]</p> <p>Q.3) Explain the causes and effects of coastal erosion in India. What are the available coastal management techniques for combating the hazard? [250 words] [15 Marks] [2022]</p> <p>Q.4) Describe the various causes and the effects of landslides. Mention components of the important components of National Landslide Risk Management strategy. [250 Words] [15 Marks] [2021]</p> <p>Q.5) Discuss about the vulnerability of India to earthquake related hazards. Give examples including the salient features of major disasters caused by earthquakes in different parts of India during the last three decades. [150 Words] [10 Marks] [2021]</p> <p>Q.6) Discuss the recent measures initiated in disaster management by the Government of India departing from the earlier reactive approach. [250 Words] [15 Marks] [2020]</p> <p>Q.7) 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? Discuss different types of vulnerability with reference to disasters. [150 Words] [10 Marks] [2019]</p> <p>Q.8) Disaster preparedness is the first step in any disaster management process. Explain how hazard zonation mapping will help disaster mitigation in the case of landslides. [250 Words] [15 marks] [2019]</p> <p>Q.9) Describe various measures taken in India for Disaster Risk Reduction (DRR) before and after signing 'Sendai Framework for DRR (2015-2030)'. How is this framework different from 'Hyogo Framework for Action, 2005'? [250 Words] [15 marks] [2018]</p> <p>Q.10) On December 2004, tsunami brought havoc on 14 countries including India. Discuss the factors responsible for occurrence of Tsunami and its effects on life and economy. In the light of guidelines of NDMA (2010) describe the mechanisms for preparedness to reduce the risk during</p>

such events. [250 Words] [15 marks] [2017]

Q.11) The frequency of urban floods due to high intensity rainfall is increasing over the years. Discussing the reasons for urban floods, highlight the mechanisms for preparedness to reduce the risk during such events. [200 Words] [12.5 Marks] [2016]

Q.12) With reference to National Disaster Management Authority (NDMA) guidelines, discuss the measures to be adopted to mitigate the impact of the recent incidents of cloudbursts in many places of Uttarakhand. [200 Words] [12.5 Marks] [2016]

Q.13) The frequency of earthquakes appears to have increased in the Indian subcontinent. However, India's preparedness for mitigating their impact has significant gaps. Discuss various aspects. [200 Words] [12.5 Marks] [2015]

Q.14) Drought has been recognized as a disaster in view of its spatial expanse, temporal duration, slow onset and lasting effects on vulnerable sections. With a focus on the September 2010 guidelines from the National Disaster Management Authority (NDMA), discuss the mechanisms for preparedness to deal with likely El Nino and La Nina fall outs in India. [200 Words] [12.5 Marks] [2014]

Q.15) How important are vulnerability and risk assessment for pre-disaster management? As an administrator, what are key areas that you would focus on in a Disaster Management System? [200 Words] [10 Marks] [2013]

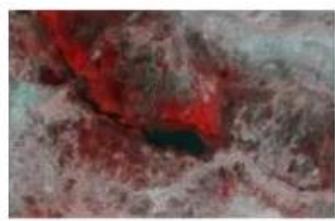
L1 Disaster Management

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DISASTER	<ul style="list-style-type: none">• Disaster : Unfortunate event, that causes loses, Can be Natural or Man made• Definition according to DM Act 2005 :<ul style="list-style-type: none">• DM Act 2005: A catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made cause, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area.• Disaster - a calamity or a catastrophe that can cause huge loss of life and property.
Hazard	<ul style="list-style-type: none">• Substance with Potential of Threat<ul style="list-style-type: none">• A substance, a state or an event which has the potential to threaten the surrounding natural environment / or adversely affect people's health.<ul style="list-style-type: none">➢ Hazards to people – death, injury, disease, mental stress➢ Hazards to goods – property damage, economic loss➢ Hazards to environment – loss of flora and fauna, pollution, loss of amenity• Types of Hazard :<p>Natural Hazards can be classified into the following categories:</p><ol style="list-style-type: none">i. Hydrologicalii. Meteorologicaliii. Climatologicaliv. Geophysicalv. Biologicalvi. Extraterrestrial

Hydrological

Flood



Landslide



Meteorological

Severe Storm



Extreme Temperature



Climatological

Forest Fire



Drought



Glacial Lake Outburst

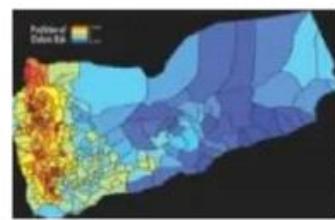


Biological

Harmful Algal Bloom



Epidemic

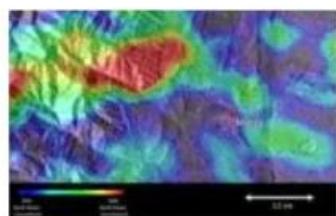


Insect Infestation

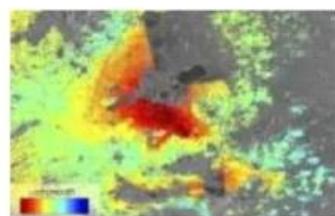


Geophysical

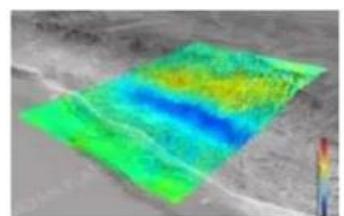
Mass Movement



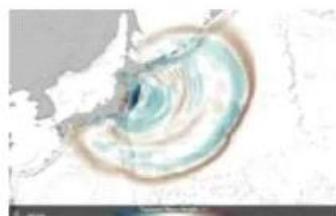
Subsidence



Earthquake



Tsunami



Volcanic Eruption



Extraterrestrial

Space Weather



Near-Earth Objects



- Man Made Hazard : Anthropoligical

Manmade Hazards can be classified into the following categories:

- i. Industrial Disasters – Gas leak, Boiler explosion, Industrial fire etc.
- ii. Chemical, Biological, Radiological, and Nuclear (CBRN) hazard

Vulnerability

- Human Vulnerability to Hazard

- The **degree of resistance** offered by a social system to the impact of a hazardous event.
- The characteristics of a person or group in terms of their **capacity to anticipate, cope with, resist and recover** from the impact of a natural or manmade hazard.
- Vulnerability is a possible future state that implies **high risk combined with an inability to cope**.
- **Key causes of vulnerability:** Geographical factors, Economic factors, Social factors, Political factors, Environmental factors

Disaster

- Sendai Framework -> Reducing Disaster Risk

Risk

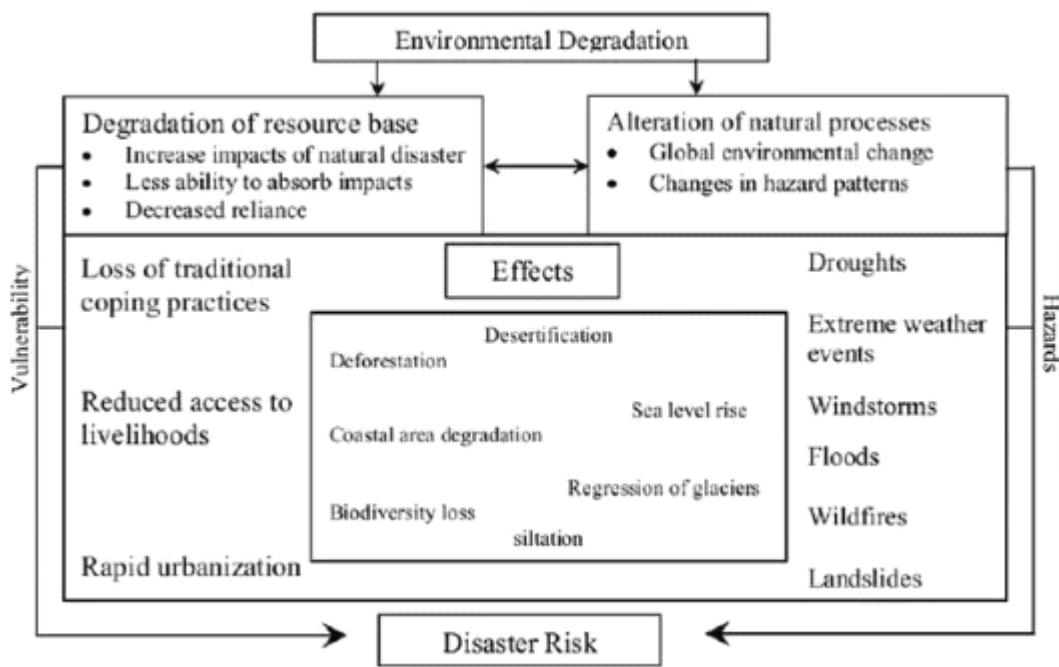
- Disaster Risk is expressed as the likelihood of loss of life, injury or destruction and damage from a disaster in a given period of time.

$$\text{Disaster Risk} = \text{Hazard} \times \text{Vulnerability} \times \text{Exposure}$$



• Environment Degradation and Disaster Risk :

- Pollution + Global Warming -> Climate change -> Extreme weather
- Ex : High temp / Cold / Rain / Draught / Forest Fire

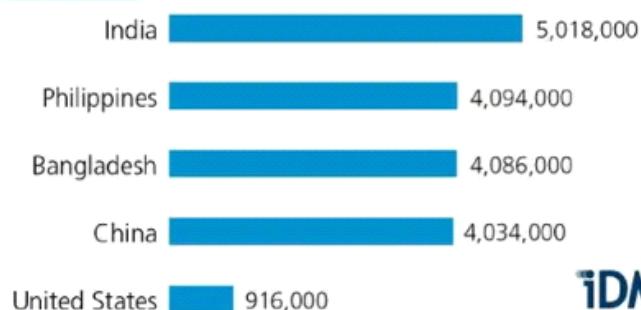


India Vulnerability

- Indian vulnerability reasons :
 - Diverse geographical features -> More prone to Hazard
 - Developing country and social issues -> vulnerable

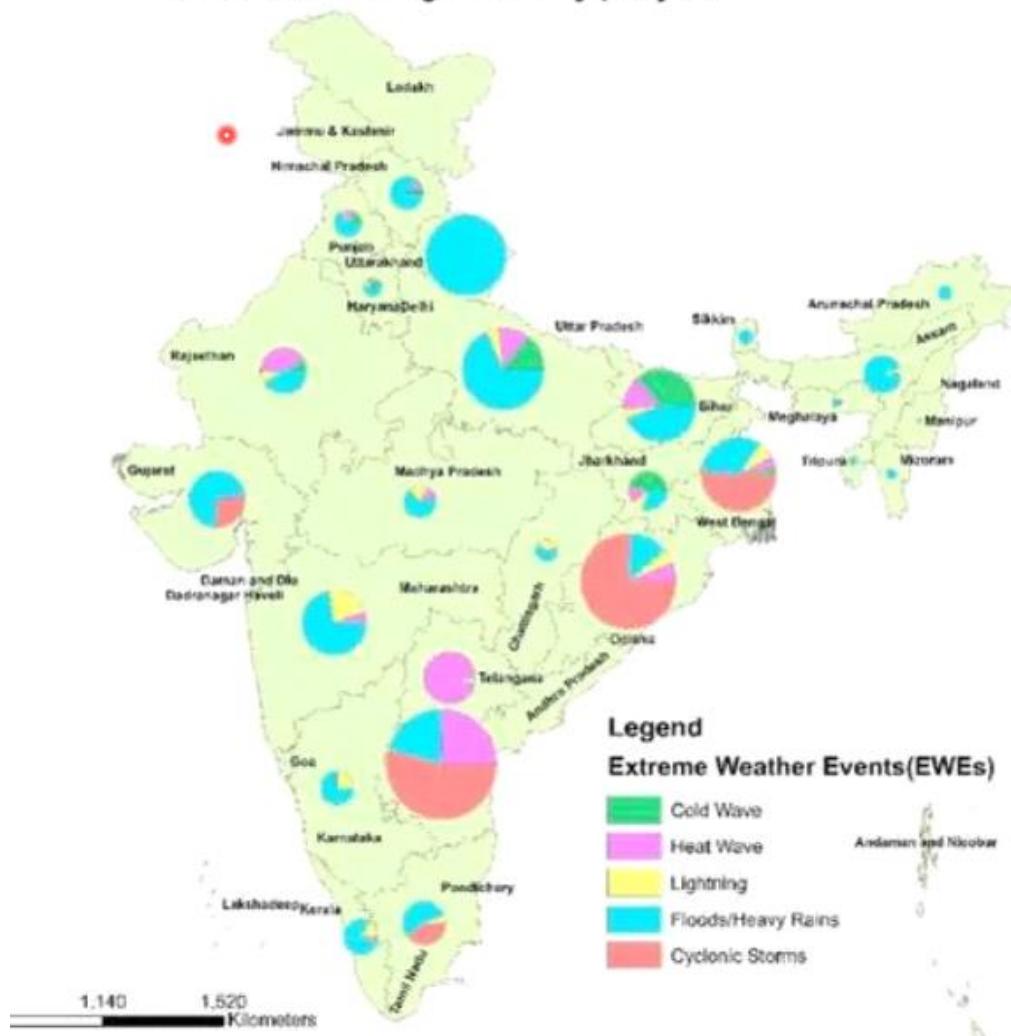
• Displacement due to Disaster :

Five countries with the most new displacements by disasters in 2019

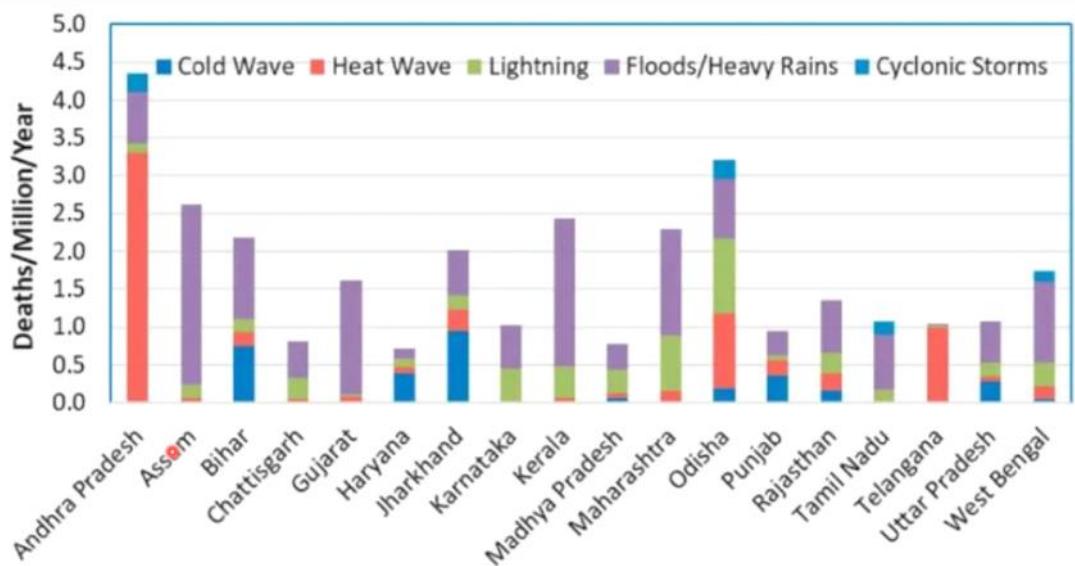


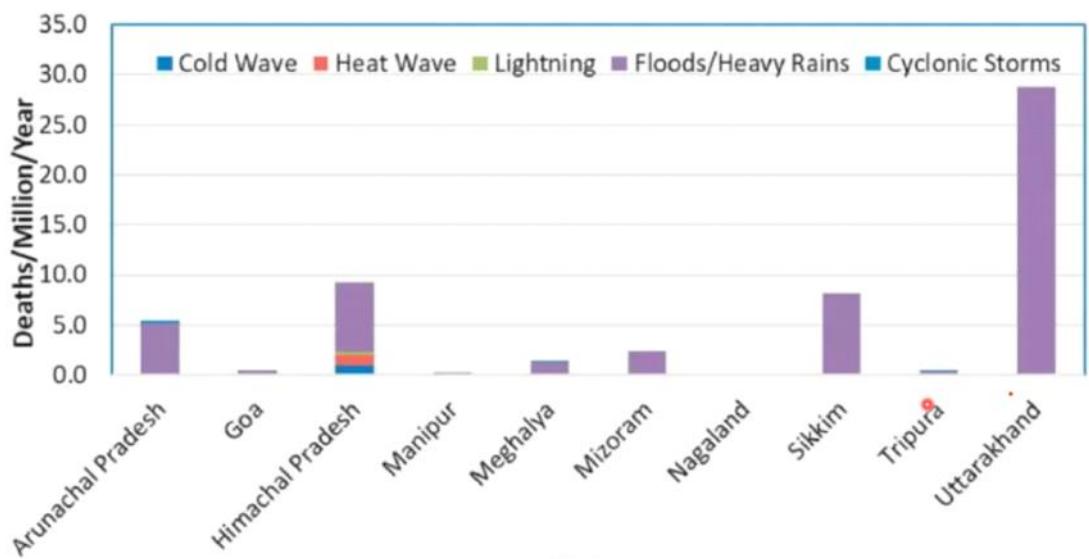
- Average Mortality in India

State wise Average Mortality per year



- State Wise :





- NDMA : Out of 36 States and BUT -> 27 are Disaster Prone



Disaster Management Cycle	<ul style="list-style-type: none"> DM Cycle : Before 1990 : After Disaster -> -> Emergency Relief Adhoc Measure : Reacting to disaster
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- After 1990 : Awakening -> Climate changes bringing more disaster -> approach transformed
 - Disaster management became Mainstream Day to day management
 - Adhoc -> Pro Active
 - 1) Pre Disaster : Preventing or mitigating impact
 - 2) During Disaster : Providing Aid
 - 3) Post Disaster Management : Preparedness

Phases in Cycle	<ul style="list-style-type: none"> • Forecasting : Early Warning System -> Alerts and evacuation <p>Pre-Disaster Phase:</p> <ul style="list-style-type: none"> • Understanding Hazards, Risk and Vulnerability • Capacity Building: Prevention, Mitigation & Preparedness • Prevention: The outright avoidance of adverse impacts of hazards and related disasters • Mitigation: The lessening or minimizing of the adverse impacts of a hazardous event. Various long-term measures, such as the construction of engineering works, insurance and land-use planning are used. • Preparedness: The knowledge and capacities of governments, professional response and recovery organisations, communities and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent or current disasters. • SAR : Immediate Response <ul style="list-style-type: none"> • Armed forces + Specialist forces (NDRF + SDRF) <p>During Disaster Phase:</p> <ul style="list-style-type: none"> • Emergency Response: It is taken up immediately after receiving the early warning. Primary goal is saving lives, protecting property and environment, and meeting basic needs. • Search and Rescue • Relief - Medical Aid, Food, Water, Shelter, Clothing etc. • Month and years after disaster • Reviving economy and livelihood, providing compensation <p>Post-Disaster Recovery Phase:</p> <ul style="list-style-type: none"> • The rehabilitation phase involves the following few weeks or months during which the priority is to enable the area to start functioning again. • Recovery and reconstruction is a much longer-term activity that attempts to return the affected area back to 'normalcy' after severe devastation.

L2 Floods and Draughts

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FLOOD	
Definition	<ul style="list-style-type: none">• Flood : Water Submerges land• Water body : carrying capacity -> capacity breached -> flood• Man -> choked water bodies -> reduce capacity -> more impact and more frequent<ul style="list-style-type: none">• A flood is an overflow of water that submerges land that is usually dry.• Flooding may occur as an overflow of water from water bodies, such as a river, lake, or ocean, in which the water overtops or breaks levees, resulting in some of that water escaping its usual boundaries, or it may occur due to an accumulation of rainwater on saturated ground.• While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, these changes in size are unlikely to be considered significant unless they flood property or drown domestic animals.• Floods can also occur in rivers when the flow rate exceeds the carrying capacity of the river channel, particularly at bends or meanders in the waterway.• Floods often cause damage to homes and businesses if they are in the natural flood plains of rivers.• While riverine flood damage can be eliminated by moving away from rivers and other bodies of water, people have traditionally lived and worked by rivers because the land is usually flat and fertile and because rivers provide easy travel and access to commerce and industry.

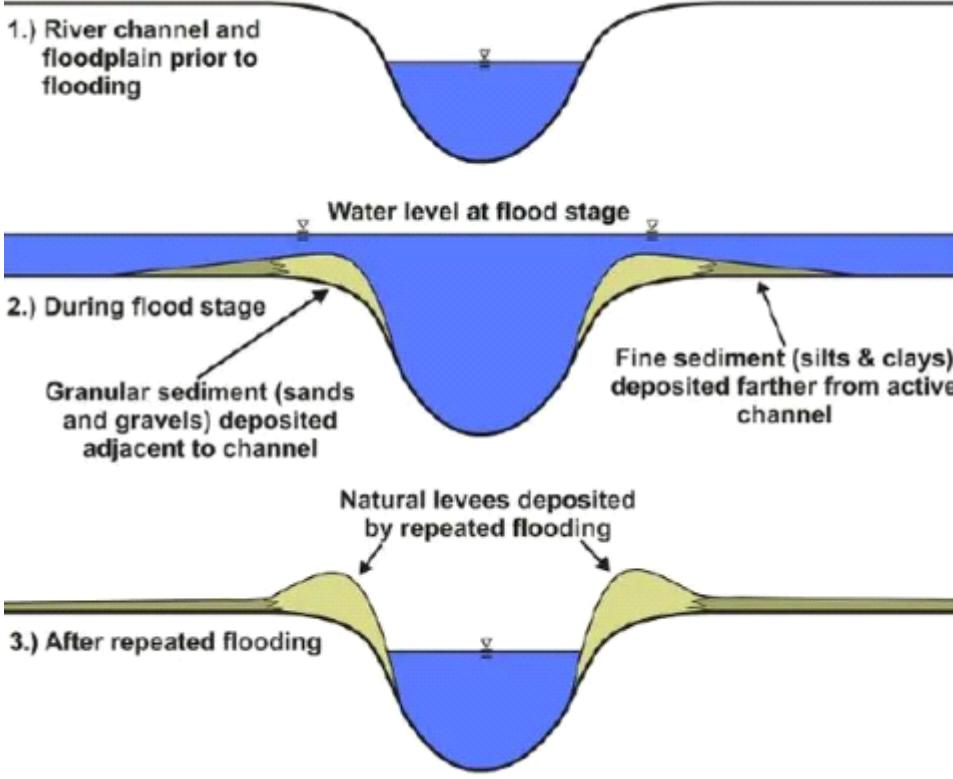
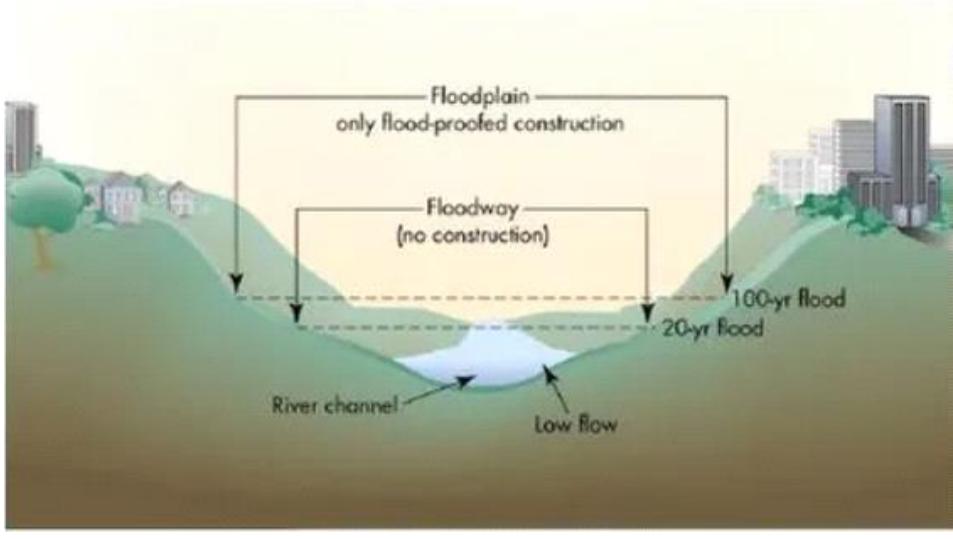
- Reasons of Flood :

- Excessive rains and Snowfall melting
- Overflowing water more than normal river level
- Heavy rainfall
- Cyclones & Storm surges
- Cloudburst
- Landslides
- Sudden release of water from reservoir & Breach of dams or embankments
- Urban Flooding - Unplanned urbanization, No proper drainage, Encroachment of natural sinks, Throwing debris
- Global warming & Climate change

- Impact of Floods

- Primary cause of death : drowning
 - i. Loss of life & property
 - ii. Damage to Agricultural crops
 - iii. Damage to Physical infrastructure
 - iv. Displacement
 - v. Disease
 - vi. Water Scarcity
 - vii. Environmental impact & Ecological loss

- Steps in preventing / mitigating floods

<p>Flood Mechanism</p>	<ul style="list-style-type: none"> • Flood Mechanism : <ul style="list-style-type: none"> • Embankments are destroyed to create Cities and Industries  <ul style="list-style-type: none"> • Mitigation : 
<p>Zone and Warning System</p>	<ul style="list-style-type: none"> • Flood Hazard Zone in India : 



- Nodal Agency for Warly Warning :

Urban Flooding	Agencies
Rainfall	Indian Meteorological Department
River Floods	Central Water Commission/State Irrigation Department
Drainage	Municipal Corporation/PWD
Geomorphologic features	Geological Survey of India
Mapping	National Remote Sensing Centre
Water Logging	PWD Department/Jal Board/Municipal Corporations

- Colour Coded Scale :

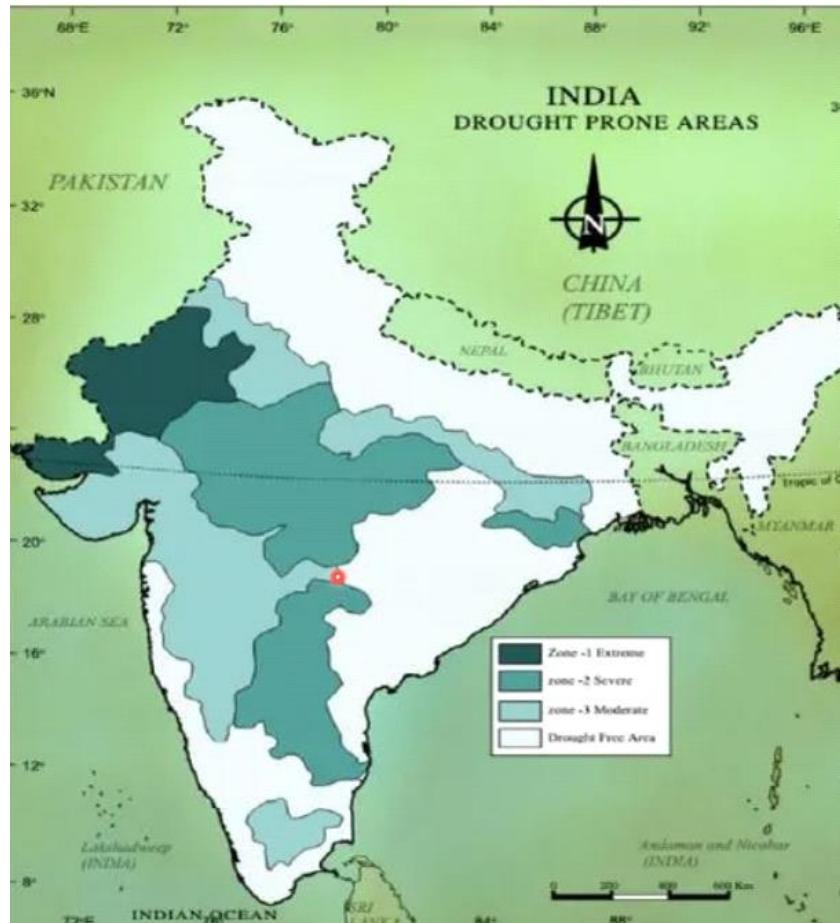
- Flood Forecasting Network of the **Central Water Commission (CWC)** covers all the major flood prone inter-State river basins in the country.

Category	Description	Stage
IV	Low Flood (Water level between Warning Level and Danger Level)	Yellow
III	Moderate Flood (Water Level below 0.50 m less than HFL and above Danger Level)	Yellow
II	High Flood (Water Level less than Highest Flood Level but still within 0.50 m of the HFL)	Orange
I	Unprecedented Flood (Water Level equal and above Highest Flood level)	Red

Mitigation	<p>1) Pre Disaster :</p> <ul style="list-style-type: none"> • Risk + Map + Plan + Warning + Forecasting • Physical Structural (Dams + Embankment to hold water) + Interlinking River project • Zoning and Planning -> Enforcement of regulation <ul style="list-style-type: none"> ◦ Restrict and regulate human activity -> local bodies inefficient • Natural Buffer : Forest and Wetland cutoff runoff and absorb excess water <p>• Flood risk analysis</p> <p>• Flood forecasting</p> <p>• Reducing runoff</p> <p>• Flood diversion</p> <p>• Construction of embankments</p> <p>• Flood plain zoning</p> <p>• Conservation of natural buffers</p> <p>• Risk transfer</p> <p>• Integrated watershed management</p> <p>• Post disaster management</p> <p>2) During Disaster :</p> <ul style="list-style-type: none"> • SAR Ops -> NDRF + Armed deployed to save people • Satellite, Robots, Helicopter and drones to track • Medical Aid + Basic Essential + Restore Economy and infra immediate Compensation <p>3) Post Disaster Management :</p> <ul style="list-style-type: none"> • Recover from damage + Reconstruction
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DROUGHT	
Definition	<ul style="list-style-type: none"> • Dry spell -> Severe water scarcity -> caused by below average rainfall <ul style="list-style-type: none"> • Severely effect economy and livelihood • Slow disaster occurs over Months and Year, Cannot be quantified, Start-end unknown • A drought is a period of below-average precipitation in a given region, resulting in prolonged shortages in its water supply, whether atmospheric, surface water or ground water. • Drought is a recurrent feature of climate and occurs in all climatic regimes. • Drought is a temporary aberration unlike aridity, which is a permanent feature of climate. <p>Why drought is different from other disasters?</p> <ul style="list-style-type: none"> • It is difficult to determine the beginning and end of the event • Duration may range from months to years • No single indicator can identify the onset and severity and its impacts

	<ul style="list-style-type: none"> A drought is a period of below-average precipitation in a given region, resulting in prolonged shortages in its water supply, whether atmospheric, surface water or ground water. Drought is a recurrent feature of climate and occurs in all climatic regimes. Drought is a temporary aberration unlike aridity, which is a permanent feature of climate. <p>Why drought is different from other disasters?</p> <ul style="list-style-type: none"> It is difficult to determine the beginning and end of the event Duration may range from months to years No single indicator can identify the onset and severity and its impacts Spatial extent is usually greater than that for other hazards Impacts are difficult to quantify and they usually magnify when the event continues from one season to the next.
Types of Draught	<ul style="list-style-type: none"> 3 stages of Draught <ul style="list-style-type: none"> Meteorological : failure of rainfall in one season, Water level reduced, short term Hydrological : failure of rainfall for 2-3 year -> water exhausted Agricultural : failure for 4-5 year -> farming unviable, barren land -> irreversible Meteorological Drought - It is defined as the deficiency of precipitation from expected or normal levels over an extended period of time. Hydrological Drought – It is best defined as deficiencies in surface and subsurface water supplies leading to a lack of water for normal and specific needs. Such conditions arise, even in times of average precipitation when increased usage of water diminishes the reserves. Agricultural Drought – It is triggered by meteorological and hydrological droughts, occurs when soil moisture and rainfall are inadequate for cultivating crops.
Impact of Draught	<ul style="list-style-type: none"> Environmental + Economic + Social Can trigger secondary disasters like diseases etc. <ul style="list-style-type: none"> Environmental Impact: Lower surface and subterranean water-levels, Increased pollution of surface water, Drying out of wetlands, Aggravated wildfires, Loss of biodiversity, Ecological imbalance and the Appearance of pests and diseases. Economic Impact: Lower agricultural productivity, Lower forests, game and fishing output, Higher food-production costs, Lower energy production levels in hydropower plants, Losses caused by depleted water tourism and transport revenue, Problems with water supply for the energy sector and for technological processes in metallurgy, mining industries and Disruption of water supplies for municipal economies. Social Impact: Migration of population, Increase in income divide and rural-urban divide, Withdrawing children from schools, Postponement of marriages, Sale of assets etc. It will also lead to famines and threatens food security leading to malnutrition and other health hazards.
Draught Zones	<ul style="list-style-type: none"> Indian Zone of Draught :



Draught Risk Management	<ul style="list-style-type: none"> Understand Hazard : Risk Analysis -> Monitoring -> Early warning System -> Mitigation Reduction of water intensive crops like Rice, sugarcane <ul style="list-style-type: none"> Moving to crops with Drought resistance. Ex : Millets Drought monitoring and early warning Conservation of natural buffers Development of irrigation infrastructure Drought prone areas program: Watershed management approach River interlinking Crop Insurance Livelihood planning Land use planning Strengthening the welfare schemes Response measures During Draught : response Measure <ul style="list-style-type: none"> Drinking water and food supply, Compensation Improving Public health infrastructure, more diseases are going to spread Track down Money lenders
Programmes for Draught	<ul style="list-style-type: none"> DPAP 1973 : Draught Prone Area Programme <ul style="list-style-type: none"> First Indian programme for draught management

Management

- Aim of optimum utilization of land, water & livestock resources, restoration of ecological balance & stabilizing income of people.
- Its objectives -
 - a) Development & management of water resources.
 - b) Soil & moisture conservation measure.
 - c) Afforestation with special emphasis on social & farm forestry.
 - d) Livestock development & dairy development.
 - e) Restructuring of cropping pattern & change in agronomic practices.
 - f) Development of subsidiary occupation.

• DDP 1977 : Desert Development Programme

- Focus on land desertification and restore ecological balance

- Long term measures for restoration of ecological balance by conserving, developing & harnessing land, water, livestock & human resources.
- Seeks to promote economic development of village community & improve economic conditions of poor & disadvantaged section of society in rural.
- Its objectives -
 - a) Mitigate adverse effects of decentralization & adverse climatic condition on crop, human & livestock population & combating desertification.
 - b) To restore ecological balance by harnessing, conserving & developing natural resources.
 - c) To implement development work through watershed approach.

• IWDP :

- Merged all programs to focus on irrigation

- Basic objective is an integrated wasteland development based on village/micro watershed plans.
- It aims at rural employment besides enhancing contents of peoples participation in wasteland development programme at all stages.
- Technical committee under C H Hanumanth Rao, recommended merging of all three programmes under common guidelines of watershed.
- Accordingly a new restructured programme - **IWMP (Integrated Watershed Management Programme)** was formed in 1995.
- From 2015-16 IWMP is being implemented as watershed component of **Pradhan Mantri Krishi Sinchai Yojana (PKSY)**.

• Neeranchal 2016-2022

- Funded by World bank with Agriculture ministry -> Focus of Irrigation

- World Bank assisted National Watershed Management Project.
- To support the Integrated Watershed Management Program (IWMP) for the improvement and conservation of water resources.
- National level as well as in the nine States of **Andhra Pradesh, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and Telangana**.

• Objectives-

1. Bring about institutional changes in watershed and rainfed agricultural management practices in India.
2. Build systems that ensure watershed programmes and rainfed irrigation management practices are better focussed, and more coordinated, and have quantifiable results.
3. Devise strategies for the sustainability of improved watershed management practices in programme areas, even after the withdrawal of project support.
4. Through the watershed plus approach, support improved equity, livelihoods, and incomes through forward linkages, on a platform of inclusiveness and local participation.

- Jal Shakti Abhiyan

- Drinking water from taps in rural areas, pipe water connection
- Recharging groundwater and rain water harvesting

Intervention Areas

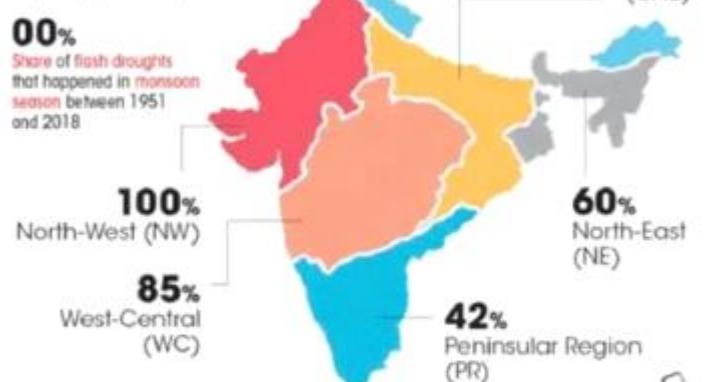


Flash Draughts

- Flash draughts which last only for few weeks or few months
- Climate change -> Erratic rainfall pattern -> NE Region lower rainfall -> water shortage
- Unrecognized crisis faced but no one pay attention

AN UNRECOGNISED CRISIS

A big percentage of the flash draughts between 1951 and 2018 occurred in monsoon, impacting kharif crops



THE WORST FOUR FLASH DROUGHTS

All occurred in monsoon, devastating crop production



1958
affected CNE and NW

1979
affected CNE, NW and WC

1986
spread across WC, CNE, NW and PR

2001
affected WC, CNE and NW

L3 Cyclones, Burst, Slide, GLOF

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CYCLONES	
Tropical Cyclones	<ul style="list-style-type: none">Violent Storms with Circular flowing winds developed in Tropical region<ul style="list-style-type: none">Tropical cyclones are violent storms that originate over seas/oceans in tropical areas and move over to the coastal areas bringing about large scale destruction due to high speed winds, very heavy rainfall and storm surge.It is a strong wind system involved in closed circulation of air around a low pressure center. The low pressure at the center is responsible for the wind speeds.This closed air circulation is a result of rapid upward movement of hot moist air which is subjected to Coriolis force.The cyclonic wind movements are anti-clockwise in the northern hemisphere and clockwise in the southern hemisphere.
Formation of Cyclones	<ul style="list-style-type: none">Requirement for creation for cyclone<ul style="list-style-type: none">Large Open Sea / OceanHigh temp 26*-27* C -> Sea water evaporationWarm Moisture Air rise up -> Dense cloud formation and low pressure centreCoriolis -> wind move in circulating motion -> VortexNeed of difference in wind sheer speed (Vertical Wind Speed)<ul style="list-style-type: none">i. Large sea surface with temperature higher than 26°-27° Cii. Presence of the Coriolis force enough to create a cyclonic vortexiii. Small variations in the vertical wind speediv. A pre-existing weak low-pressure area or low-level-cyclonic circulationv. Upper divergence above the sea level systemOcean waters having temperatures of 26°-27° C or more is the source of moisture which feeds the storm. The condensation of moisture releases enough latent heat of condensation to drive the storm.Steps of formation

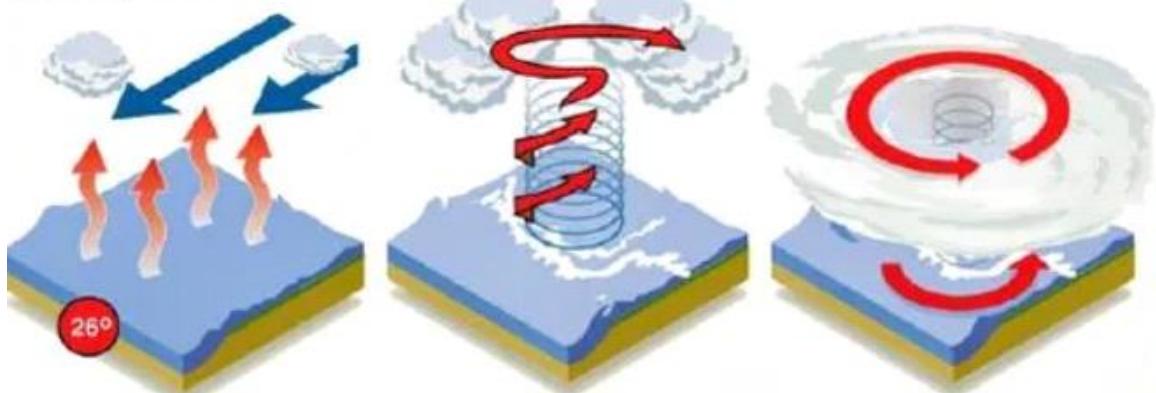
How tropical storms are formed

High humidity and ocean temperatures of over 26°C are major contributing factors

Water evaporates from the ocean surface and comes into contact with a **mass of cold air**, forming clouds

A column of low pressure develops at the centre. Winds form around the column

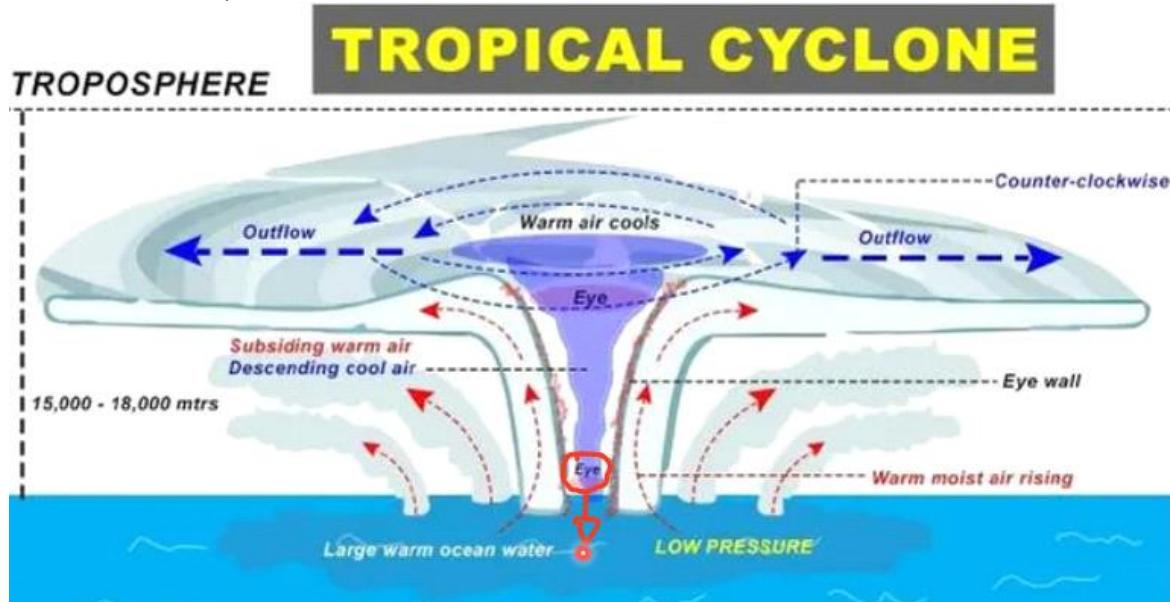
As pressure in the central column (the eye) weakens, the speed of the wind around it increases



Saffir-Simpson hurricane wind scale

Category 1	Category 2	Category 3	Category 4	Category 5
Minimal damage	Moderate damage	Extensive damage	Extreme damage	Catastrophic
Winds 119-153 kph	Winds 154-177 kph	Winds 178-208 kph	Winds 209-251 kph	Winds 252 kph and more

- Cross Section of Cyclone :



Regions of Cyclones

- Favourite Breeding grounds of Tropical Cyclones :
 - South-east Caribbean – East Coast of North America - Hurricanes
 - Philippines, eastern China and Japan - Typhoons
 - Bay of Bengal and Arabian Sea – Cyclones
 - North-west Australia - Willy-Willy
 - Around south-east African coast and Madagascar-Mauritius islands

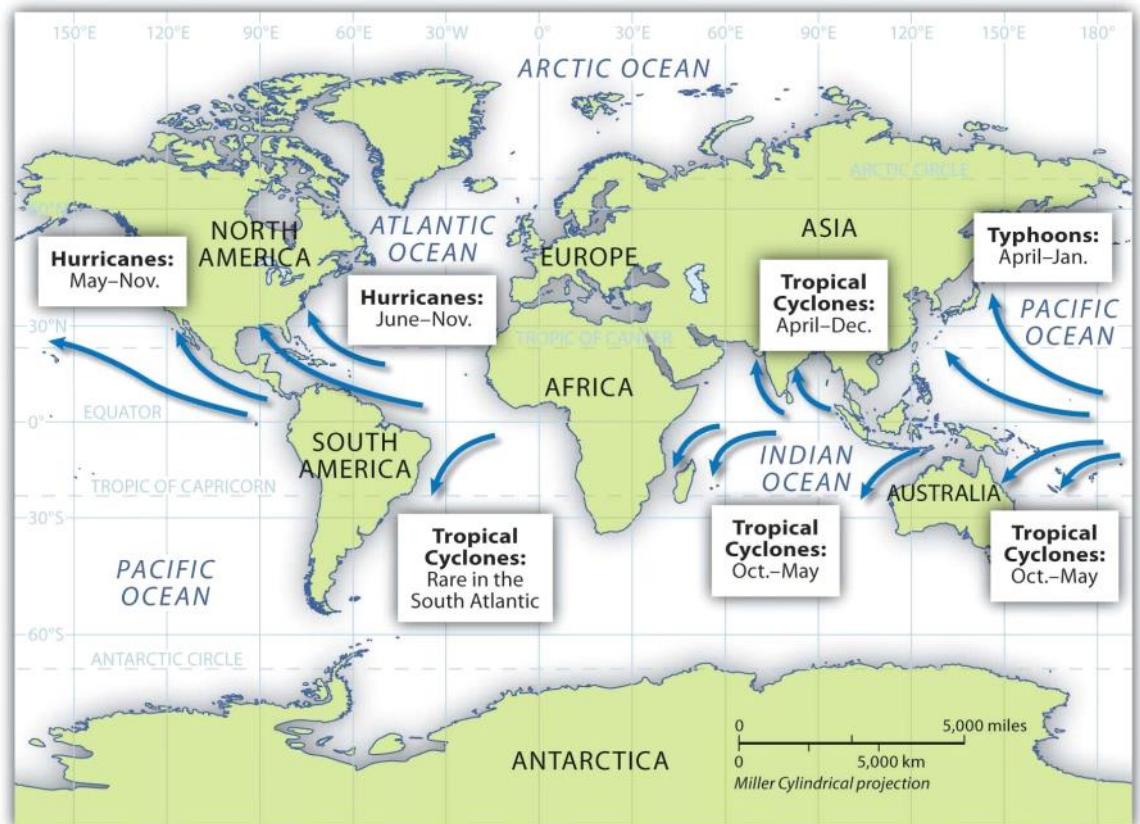


Fig: Distribution of cyclones in tropical regions.

Impact of Cyclones	<ul style="list-style-type: none"> • Landfall : Contact of cyclone with land -> Supply of moisture is cutoff • Start moving at high speed : 180-280 kmph • Need of timely evacuation • Coastlines affected severely : Nuclear power plant, industry, Naval base <p>Landfall brings very high speed winds, torrential rains, storm surge & flooding</p> <ul style="list-style-type: none"> • Loss of lives • Destruction of property • Damage to infrastructure • Destruction of crops • Environmental damage
Cyclones in India	<ul style="list-style-type: none"> • Months -> witness Cyclone <ul style="list-style-type: none"> • April to May : Pre monsoon season • Sep to Nov : Post monsoon season • Tropical cyclones originate over the Bay of Bengal, Arabian Sea and the Indian Ocean. • These tropical cyclones have very high wind velocity and bring heavy rainfall and hit the Indian Coastal states of Tamil Nadu, Puducherry, Andhra Pradesh, West Bengal, Odisha, Kerala, Gujarat & Maharashtra. <ul style="list-style-type: none"> • Indian region affected by Cyclones



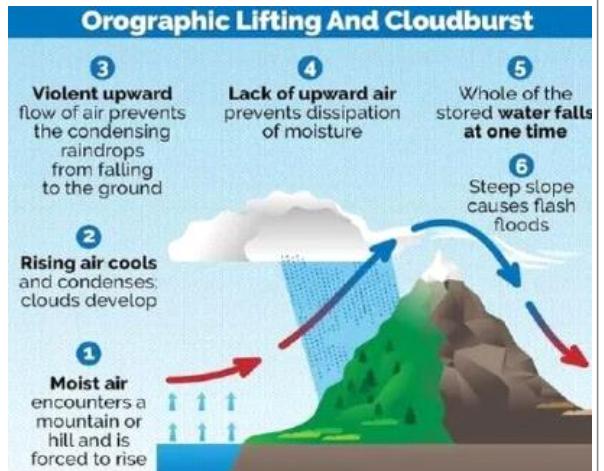
- Reason of Bay of Bengal to be prone to Cyclones
 - 5 time more frequent than Arabian Seas, and more severe
 - Bay of Bengal is closed structure -> more heating

- Bay of Bengal sees approximately **five times** as many cyclones as compared to the Arabian Sea.
- In addition, cyclones in the Bay of Bengal are **stronger and deadlier**.
- Nearly **58% of cyclones formed in the Bay of Bengal reach the coast** as compared to only 25% of those formed in the Arabian Sea.
- 1. **Temperature difference:** The low-pressure system of a cyclone needs a continuous supply of heat energy and as the **Bay of Bengal is warmer than the Arabian sea**, it is able to provide the heat energy needed to sustain the low-pressure system.
- 2. **Sea surface temperatures and humidity:** both directly correlate with chances of cyclone formation.
 - i. The **Bay of Bengal receives higher rainfall and constant inflow of fresh water from the Ganga and Brahmaputra rivers.**
 - ii. This means that the Bay's surface water keeps getting refreshed, making it **impossible for the warm water to mix with the cooler water below**, making it ideal for depression.
 - iii. On the other hand, the **Arabian Sea receives stronger winds that help dissipate the heat**, and the **lack of constant fresh water supply helps the warm water mix with the cool water**, reducing the temperature.
- 3. **Absence of large landmass between the Pacific Ocean & Bay of Bengal**, allows cyclonic winds to easily move into the Bay of Bengal.
- 4. **Cyclones from Pacific ocean:** low-pressure system originating from the Pacific ocean also travel towards the left to the Bay of Bengal.

Cyclone

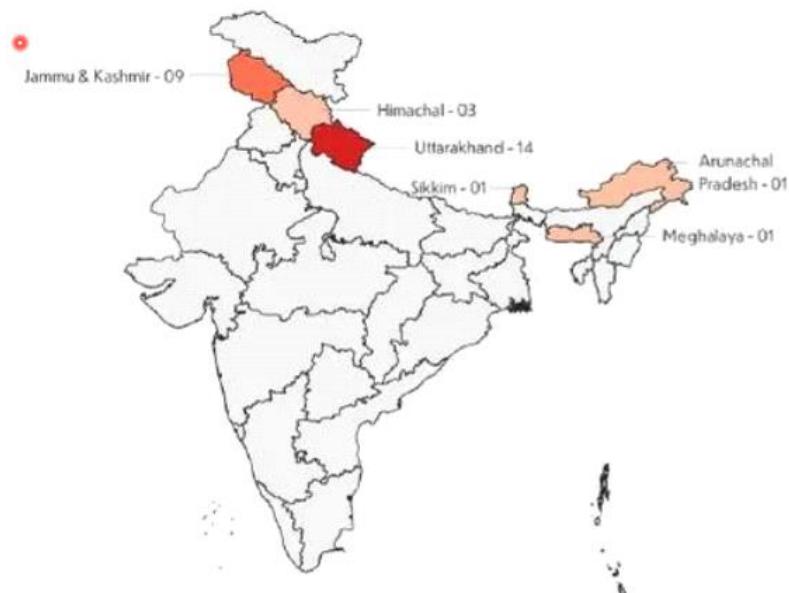
- Pre Disaster : Forecasting and Warning by IMD

Mitigation	<ul style="list-style-type: none"> • Early warning & Forecasting system - IMD • Flood management measures • Land use planning: CRZ rules • Conservation of natural buffers • Livelihood planning • Construction of cyclone shelters • Engineered structures • Institutional capacity building • The structural measures include construction of cyclone shelters, construction of cyclone resistant buildings, road links, culverts, bridges, canals, drains, saline embankments, surface water tanks, communication and power transmission networks etc. • Non-structural measures like early warning dissemination systems, management of coastal zones, awareness generation and disaster risk management and capacity building of all the stakeholders involved. • These measures are being adopted and tackled on a State to State basis under the National Cyclone Risk Mitigation Project (NCRMP) being implemented through World Bank Assistance.
National Cyclone Risk Mitigation Project	<ul style="list-style-type: none"> • NCRMP -> Spread awareness and reduce vulnerability. <p>The main objective of the NCRMP is to reduce vulnerability of coastal communities to cyclone and other hydro meteorological hazards through -</p> <ul style="list-style-type: none"> • improved early warning dissemination systems • enhanced capacity of local communities to respond to disasters • improved access to emergency shelter, evacuation, and protection against wind storms, flooding and storm surge in high areas • strengthening Disaster Risk Mitigation capacity at central, state and local levels • enable mainstreaming of risk mitigation measures into the overall development agenda
Naming of Cyclone	<ul style="list-style-type: none"> • Naming System : Assigned for Scientific research and spread awareness. • UMO : Global naming convention -> Suggest name on rotational basis <p style="text-align: center;">RSMC – Regional Specialized Meteorological Centre for Tropical Cyclones over North Indian Ocean</p> <p style="text-align: center;">Bangladesh, Maldives, Myanmar, Pakistan, Sri Lanka, Oman, Yemen, Thailand, Iran, Saudi Arabia, Qatar and UAE</p>

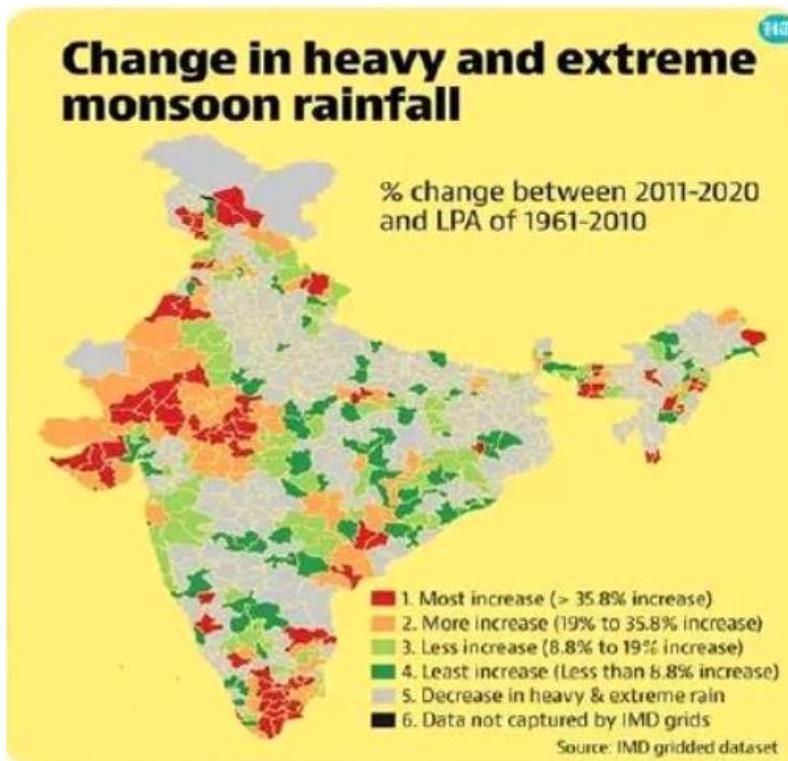
CLOUDBURST	
Definition	<ul style="list-style-type: none"> • Cloudburst : Heavy Rain in Short period of time over short area <ul style="list-style-type: none"> • Overwhelm drainage capacity -> Led to Flash flood • Occur because of Orographic Lift -> Cold -> Sudden Condensation -> Sudden Rain • A cloudburst is an extreme amount of precipitation in a short period of time, sometimes accompanied by hail and thunder, which is capable of creating flood conditions. • Cloudbursts can quickly dump large amounts of water. • However, cloudbursts are infrequent as they occur only via orographic lift or occasionally when a warm air parcel mixes with cooler air, resulting in sudden condensation. 
Zones in India	<ul style="list-style-type: none"> • IMD -> Predict cloudburst, but require localised infrastructure • Rainfall : 10cm/hour in small region <ul style="list-style-type: none"> • Events associated with rainfall in excess of 10 cm/hour in smaller geographical area of approximately 20-30 square km. • Events associated with heavy rainfall in mountain region of Himalayas, Western Ghats, and northeastern hill states of India. • In the Indian subcontinent, a cloudburst usually occurs when a monsoon cloud drifts northwards, from the Bay of Bengal or Arabian Sea across the plains, then onto the Himalayas and bursts, bringing rainfall as high as 75 mm per hour. • Impact of Cloudbursts: <ol style="list-style-type: none"> Flash floods – Loss of life Triggers landslides/soil erosion Damages Infrastructure Siltation of rivers Loss of flora & fauna Socio-economic loss • Impact of cloudburst : <ol style="list-style-type: none"> Flash floods – Loss of life Triggers landslides/soil erosion Damages Infrastructure Siltation of rivers Loss of flora & fauna Socio-economic loss

 CLOUD BURST INCIDENTS IN THE INDIAN HIMALAYAN REGION

April - September 2020



• Zones in India



Cloudburst Risk Reduction	<ul style="list-style-type: none"> IMD + CDAC working on cloudburst tracking 37 Doppler radars tracking formation of clouds By 2030 : 86 radars installation Provide alert before 1-2 hour -> Evacuation
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Expanding dopplers to predict cloudbursts: IMD DG

At present, it has 37 radars across India and will add 25 more by 2025. The IMD DG pointed out the enhancement may not be sufficient as old and redundant radars will have to be replaced with new ones. "We are planning to add 24 more radars across the country after 2025 and take the total number to 86 by 2030," he said.

IMD is also working with the Ministry of Agriculture and has come up with a plan to set up automatic weather stations in every block and automatic rain gauge in each panchayat of the country. "States like Odisha are augmenting their weather observation systems. The plan is to have an integrated observation system which IMD will monitor and provide the forecasts," said Mohapatra.

To issue forecasts for urban flooding, systems have already been installed in Chennai, Mumbai and Guwahati. Similar system will soon be installed in New Delhi, Kolkata, Pune, Ahmedabad, Varanasi and other cities.

"Another project has been taken up with the Ministry of Earth Sciences, Centre for Development of Advanced Computing and other organisations for five cities including Bhubaneswar and Cuttack to set up augmented weather observation systems," said Mohapatra.

- Measures same as floods mitigation : Awareness and Alert
 - Structural & Non-structural measures
 - Rescue & Rehabilitation
 - Co-ordination, training etc.

LANDSLIDES / AVALANCHE

Definition

- Sudden earth movement in downward slopes -> Slope slides down due to gravity
- Mass Wasting : High volume
 - A landslide is defined as the sudden movement of a mass of rock, debris, or earth down a slope.
 - Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity.
 - In many cases, the landslide is triggered by a specific event (such as a heavy rainfall, an earthquake, a slope cut to build a road, and many others).

- Types : Snow / Debris / Rock Avalanche



Snow Avalanche

Debris Avalanche



Rock Avalanche

- Natural Factors :

Natural causes of landslides include -

- Saturation by rain water infiltration, snow melting, or glaciers melting
- Rising of groundwater or increase of pore water pressure
- Loss or absence of vertical vegetative structure, soil nutrients, and soil structure
- Erosion of the top of a slope by rivers or sea waves
- Physical and chemical weathering
- Ground shaking caused by earthquakes, which can destabilize the slope directly
- Volcanic eruptions

- Anthropological Factors :

Landslides are aggravated by human activities, such as –

- Deforestation, cultivation and construction
- Vibrations from machinery or traffic
- Blasting and mining
- Earthwork (e.g. by altering the shape of a slope, or imposing new loads); in shallow soils, the removal of deep-rooted vegetation
- Agricultural or forestry activities
- Urbanization
- Land degradation and extreme rainfall can increase the frequency of erosion and landslide phenomena

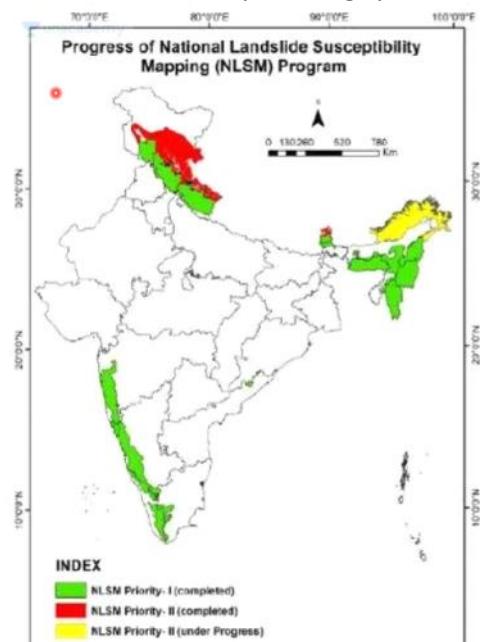
Landslides

- Hazard Vulnerability Map : 12.6 % Land prone to land slides

Zones	<ul style="list-style-type: none"> In India, about 0.42 million sq. km or 12.6% of land area, excluding snow covered area, is prone to landslide hazard. 0.18 million sq. km falls in North East Himalaya, including Darjeeling and Sikkim Himalaya 0.14 million sq. km falls in North West Himalaya (Uttarakhand, Himachal Pradesh and Jammu & Kashmir) 0.09 million sq. km in Western Ghats and Konkan hills (Tamil Nadu, Kerala, Karnataka, Goa and Maharashtra) 0.01 million sq. km in Eastern Ghats of Araku area in Andhra Pradesh. 	<p>LANDSLIDE ZONES</p> <ul style="list-style-type: none"> Very high hazard High hazard Moderate/Moderately high hazard Low hazard Very low hazard
Landslides Mitigation	<ul style="list-style-type: none"> 2021 Feb : Chamoli Disaster (Uttarakhand) <ul style="list-style-type: none"> Tapovan Hydropower -> Several people crushed during Flash floods Reason of flash flood : GLOF -> Glacial lake outburst flood -> false Satellite images -> massive piece of rock missing -> water spilled out -> Flash flood 	

- Early warning system
- Preparedness
- Landslide zonation map
- Land Use regulation
- Afforestation
- Structural & Non-structural measures

- NLSM : National Landslide Susceptibility Mapping Programme
 - Identification of vulnerable slope and monitoring regularly
 - To create early warning system -> In progress



Objectives

- 1) To create a dynamic **National Landslide Susceptibility Geodatabase** for India.
- 2) To prepare GIS - based seamless Landslide Susceptibility Maps of India on 1:50,000 scale.
- 3) To prepare a nation-wide repository on GIS-based Landslide Inventory.

Disaster Linkage	<ul style="list-style-type: none"> • In High Altitude areas : Flood -> Landslides -> Flood • Flash flood -> saturate soil with water -> loosen soil -> landslides • Landslides -> Debris move to valley -> Water build up -> dam collapse -> Flash Floods • Same Cycle with Earthquake -> Landslide -> Earthquake
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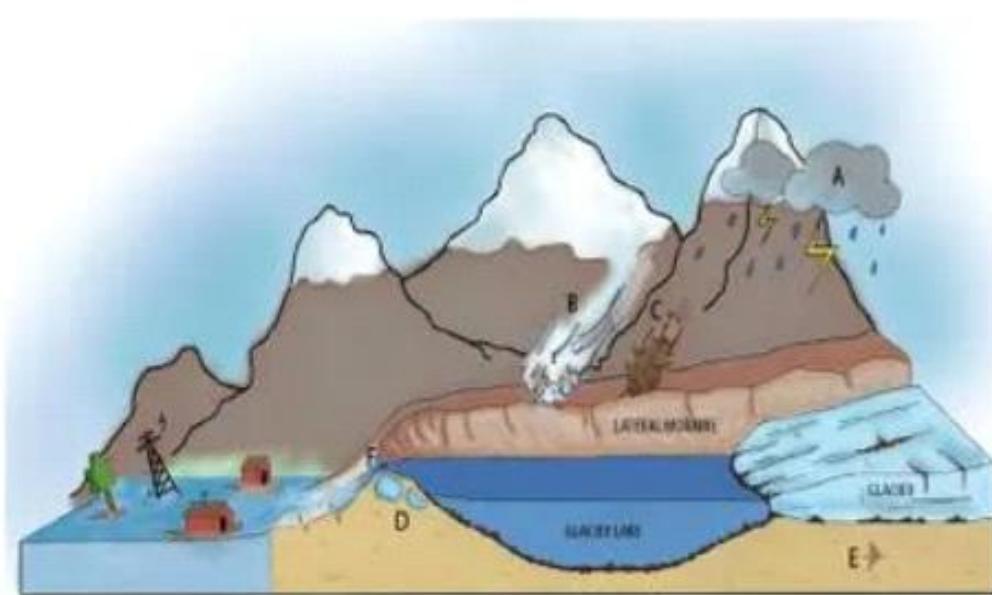
GLOF	<ul style="list-style-type: none"> • Glacier Lake Outburst Flood
Definition	<ul style="list-style-type: none"> • Global Warming -> Glacier ice melting -> Glacial lake -> Create natural dam • Certain event : heavy rainfall, landslides -> Push water out -> Flash floods

INTRODUCTION

Sudden release of water from a glacier lake is called Glacier Lake Outburst Flood (GLOF). This can threaten human lives and cause damage to the environment & infrastructure. The scientific community is currently focusing on monitoring of existing glacier lakes, identifying sites where glacier lakes are likely to form in the future, and measures to prevent floods or minimize damages.

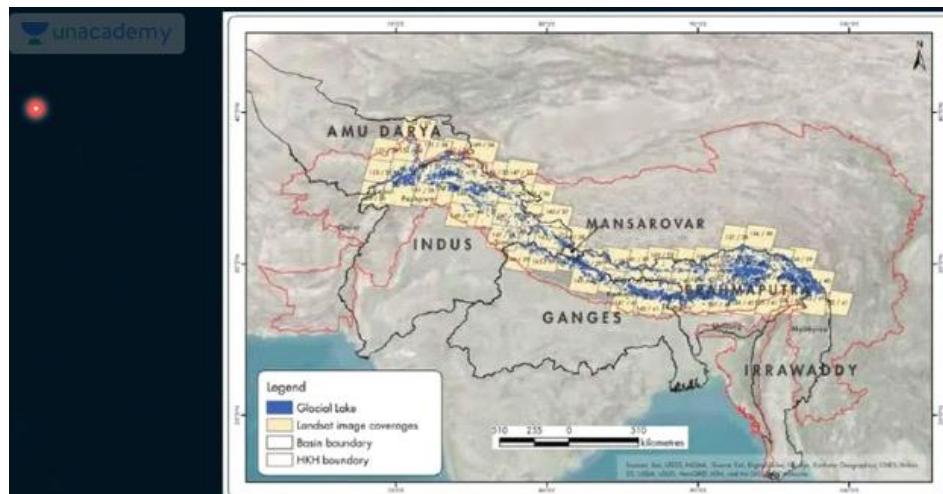
HIGHLIGHTS

- Climate change can lead to glacier retreat and formation of new glacier lakes
- Recent inventory mapped 644 glacier lakes in Sikkim covering an area of 29.70 km²
- Early warning systems and water siphoning can mitigate GLOF risk
- Divecha Centre for Climate Change (DCCC) has developed a technique to predict lake expansion and identify new lake sites



GLOF Zones

- Multiple glacier presents feeding rivers and tributaries
 - 2500+ -> Glacial lakes present
 - 1000+ -> Vulnerable
 - 300-400 -> Risk of GLOF



Among the 25,614 glacial lakes identified in five major river basins, Brahmaputra Basin has the highest number of glacial lakes (61.1 per cent) followed by Indus (18 per cent), Ganga (14.5 per cent), Amu Darya (4.6 per cent), and Irrawaddy Basins (1.1 per cent).

GLOF Mitigation

- NDMA Guidelines for GLOF
 - Mapping -> Surveillance (Drones, Satellites)

- Synthetic Aperture Radar : Works in night and cloud covered areas, 24X7 Surveillance
 - Regulation Construction and Human Activity
 - Awareness and training local people
- Identifying & Mapping dangerous Glacial lakes
 - Use of Technology (Synthetic-Aperture Radar imagery)
 - Structural Measures
 - Uniform codes for construction activity
 - Enhancing early warning systems
 - Training local manpower.

L4 Heat Cold waves, Earthquake, Tsunami

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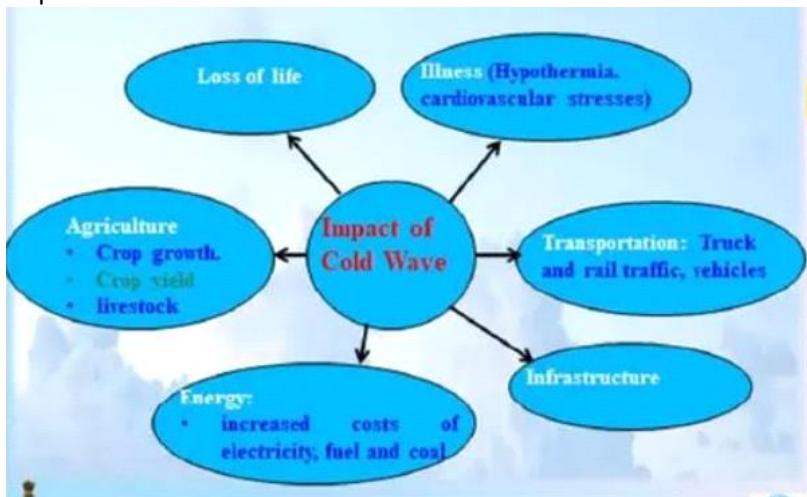
HEAT WAVES	
Definition	<ul style="list-style-type: none">• Extreme Temperature spell : High temp + Humidity + Lack of Wind<ul style="list-style-type: none">• A Heat Wave is a period of abnormally high temperatures, when the actual maximum temperature (AMT) of a place is significantly higher than normal maximum temperature (NMT).• It occurs during the summer season in the North-Western and South Central parts of India.• Heat Waves typically occur between March and June, and in some rare cases even extend till July.• The extreme temperatures and resultant atmospheric conditions adversely affect people living in these regions as they cause physiological stress, sometimes resulting in death.• Higher daily peak temperatures and longer, more intense heat waves are becoming increasingly frequent globally due to climate change.• Criteria for Declaring Heat waves : by IMD<ul style="list-style-type: none">• Temp : 40°C Plain, 37°C Costal, 30°C in hilly• High for 2 consecutive days and marked at 2 station• $45^{\circ}\text{C} > \text{temp}$ for 2 consecutive days at any place• The India Meteorological Department (IMD) has given the following criteria for Heat Waves:<ol style="list-style-type: none">1. AMT recorded at a place exceeds the threshold value which depends on humidity and normal temperature of a place: 40 degree C in plains, 37 degree C coastal stations and 30 degree C in hilly regions.2. The declaration is made when the AMT is significantly higher than NMT at atleast two stations in a meteorological subdivision for at least two consecutive days.<ul style="list-style-type: none">▪ When NMT of a station is less than or equal to 40 degree C and Temperature Departure from normal is + 5 to 6 degree C.▪ When NMT of a station is more than 40 degree C and temperature departure from normal is + 4 to 5 degree C.3. AMT remains 45 degree C or more, irrespective of NMT.
Impact of	<ul style="list-style-type: none">• Impact on Poor Peoples - > No Cooling solution

Heat waves	<ul style="list-style-type: none"> The health impact of Heat Waves typically involves - dehydration, heat cramps, heat exhaustion and/or heat stroke. The signs and symptoms are as follows: Heat Cramps: Edema (swelling) and Syncope (fainting) generally accompanied by fever below 39°C i.e. 102°F. Heat Exhaustion: fatigue, weakness, dizziness, headache, nausea, vomiting, muscle cramps and sweating. Heat Stroke: body temperatures of 40°C i.e. 104°F or more along with delirium, seizures or coma. This is a potentially fatal condition.
Indian Zone	<ul style="list-style-type: none"> Early Warning Agency -> IMD Skymet Weather Report : Heat Map
Heat wave risk Management	<ul style="list-style-type: none"> We can prevent the death caused by Heat waves Reducing exposure, taking fluid + electrolytes, Shelter, Electricity and water supply <ul style="list-style-type: none"> Early warning system Natural buffers Minimizing water and electricity supply cuts Strengthening the public health institutions to deal with heat stress-related ailments Public awareness Public cooling places Provision of drinking water Strengthening the firefighting facilities Climate change mitigation efforts

Cold WAVES	
Definition	<ul style="list-style-type: none"> Extreme cold spell :

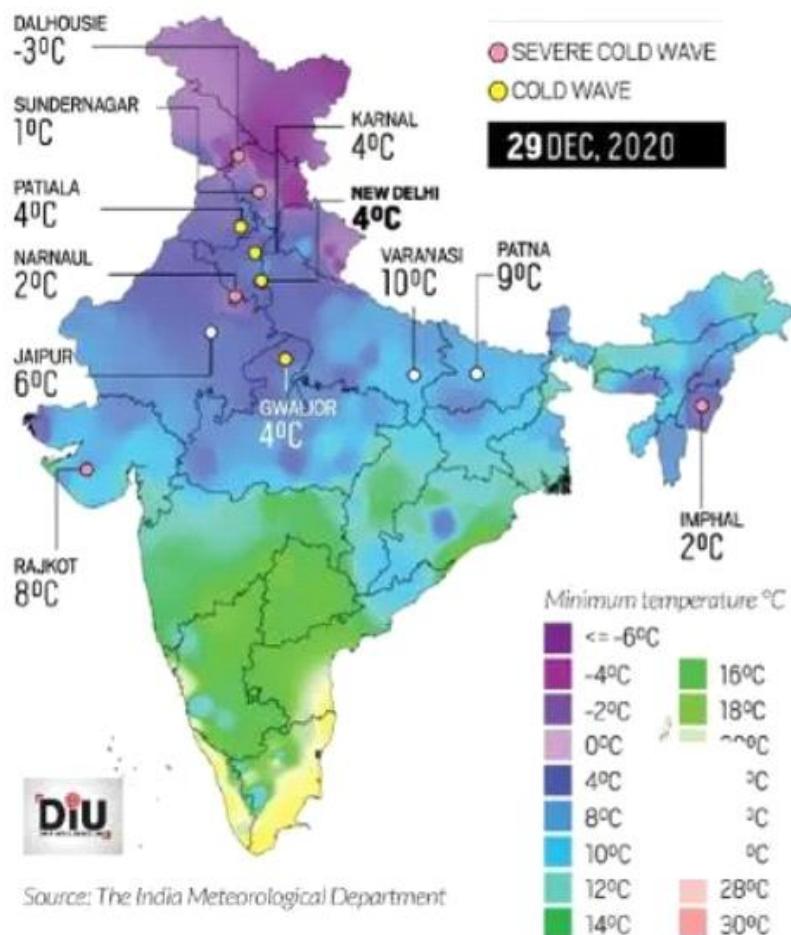
- Minimum temperature of station is 10 deg cel or less for plains & 0 deg cel or less for hilly region.
- The departure of minimum temperature from normal is 4.5 to 6.4 deg Celsius.
- It is referred as **severe cold wave** if the departure of minimum temperature from normal is more than 6.5 deg Celsius.

- Impact of Cold wave

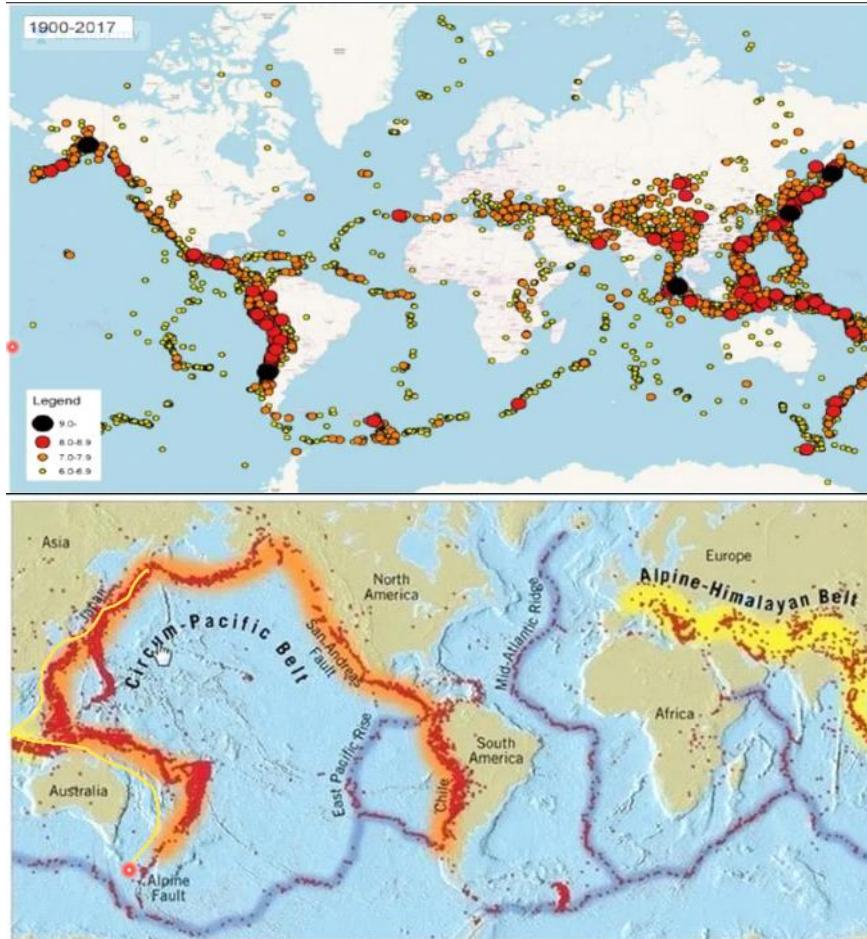


India Zone for Cold Wave

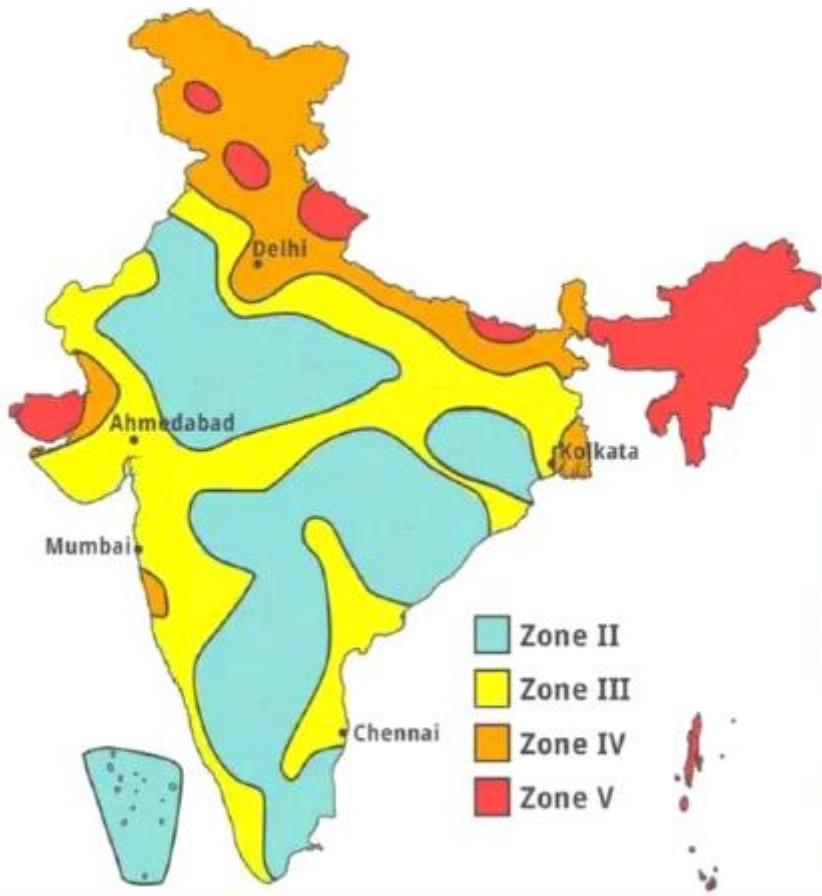
- Northern peninsular India is prone to Cold wave



Definition	<ul style="list-style-type: none"> Movement of Tectonic plates -> Seismic activity <ul style="list-style-type: none"> An earthquake is shaking or trembling of the earth's surface, caused by the seismic waves or earthquake waves that are generated due to a sudden movement (sudden release of energy) in the earth's crust or upper mantle. Causes of Earthquakes <ol style="list-style-type: none"> Plate tectonics Destabilization of fault lines Volcanic activity Human Induced Earthquakes
Distribution of Earthquake	<ul style="list-style-type: none"> Impact on earthquake : <ul style="list-style-type: none"> Densely populated cities are more vulnerable Loss of lives Damage to infrastructure Electric short circuits and fire Landslides Flash floods Tsunamis Ring of fire + Alpine Himalayan belt + Mid oceanic ridges <ul style="list-style-type: none"> Earth's major earthquakes occur mainly in belts coinciding with the margins of tectonic plates. The most important earthquake belt is the Circum-Pacific Belt, which affects many populated coastal regions around the Pacific Ocean - for example, those of New Zealand, New Guinea, Japan, the Aleutian Islands, Alaska, and the western coasts of North and South America. The seismic activity is by no means uniform throughout the belt, and there are many branches at various points. Because at many places the Circum-Pacific Belt is associated with volcanic activity, it has been popularly dubbed the "Pacific Ring of Fire" The Pacific Ring of Fire accounts for about 68% of all earthquakes. A second belt, known as the Alpine Belt (Himalayas and Alps). The energy released in earthquakes from this belt is about 15% of the world total. The mid-world mountain belt (Alpine Belt) extends parallel to the equator from Mexico across the Atlantic Ocean, the Mediterranean Sea from Alpine-Caucasus ranges to the Caspian, Himalayan mountains and the adjoining lands. There also are striking connected belts of seismic activity, mainly along oceanic ridges - including those in the Arctic Ocean, the Atlantic Ocean, and the western Indian Ocean and along the rift valleys of East Africa. Coincidence of Volcanic zones and earth wake zones 



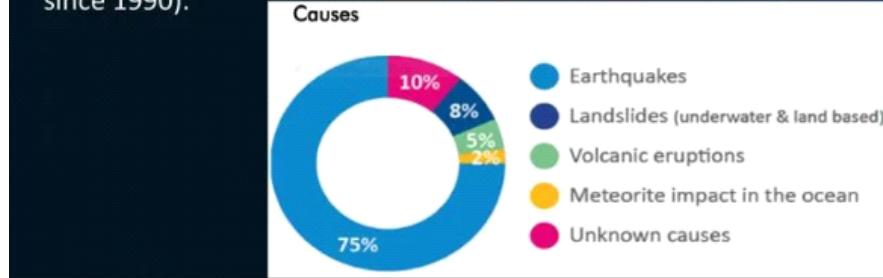
- Indian Seismic Zones**
- Zone II (safest) -> Zone V (Most prone to earth wake)
 - NE : Pacific Ring of fire
 - Kutch region
 - Koyna dam region in Maharashtra : Zone IV
 - Water contained in Dam -> Disturbance inside earth



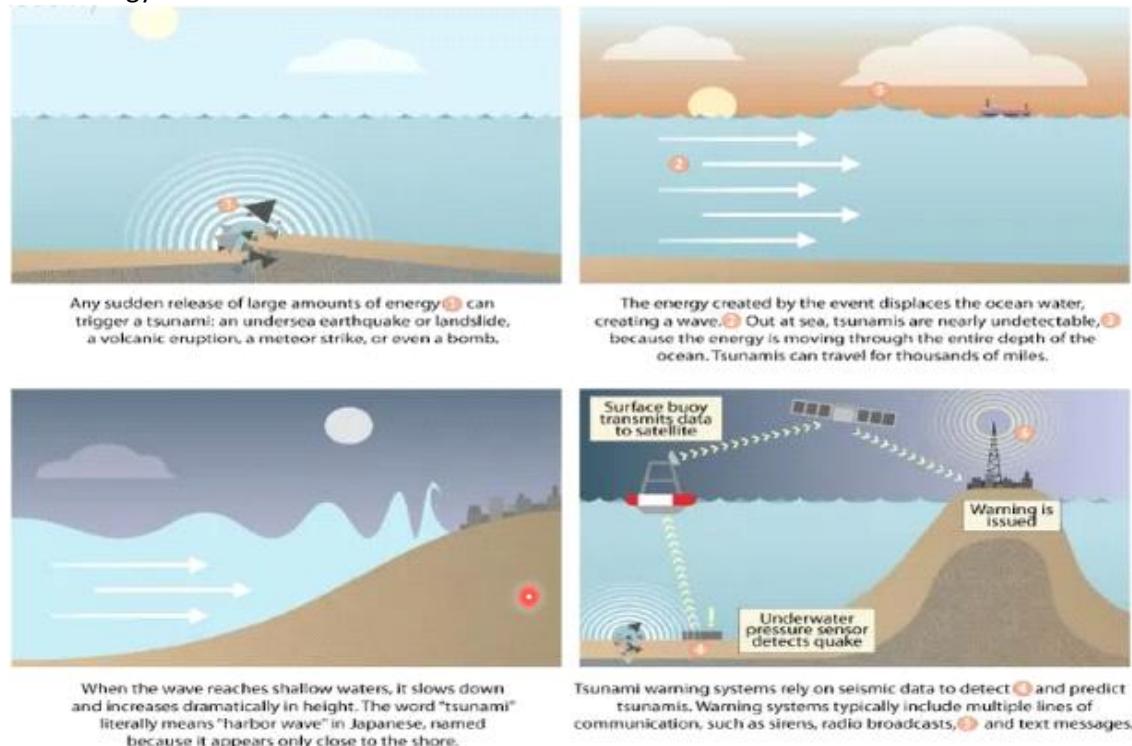
Mitigation Risk of Earthquake	<ul style="list-style-type: none"> • Forecasting using seismograph <ul style="list-style-type: none"> • Hazard & Vulnerability mapping • Land Use regulation • Earthquake-resistant design and construction of new structures • Seismic strengthening and retrofitting of lifeline and priority structures • Regulation and enforcement • Creation of public awareness on seismic safety and risk reduction • Capacity development (including education, training, R&D) • Effective emergency response
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TSUNAMI	
Definition	<ul style="list-style-type: none"> • Long wavelength waves occurring in Open seas and oceans

- A tsunami is a series of **very long-wavelength waves** in large water bodies like seas or large lakes caused by a major disturbance above or below the water surface or due to the displacement of a large volume of water.
- Earthquakes, Volcanic eruptions, Landslides, Underwater explosions, Meteorite impacts, etc. have the potential to generate a tsunami.
- Subduction zones off Chile, Nicaragua, Mexico and Indonesia have created killer tsunamis.
- The Pacific among the oceans has witnessed the greatest number of tsunamis (over 790 since 1990).



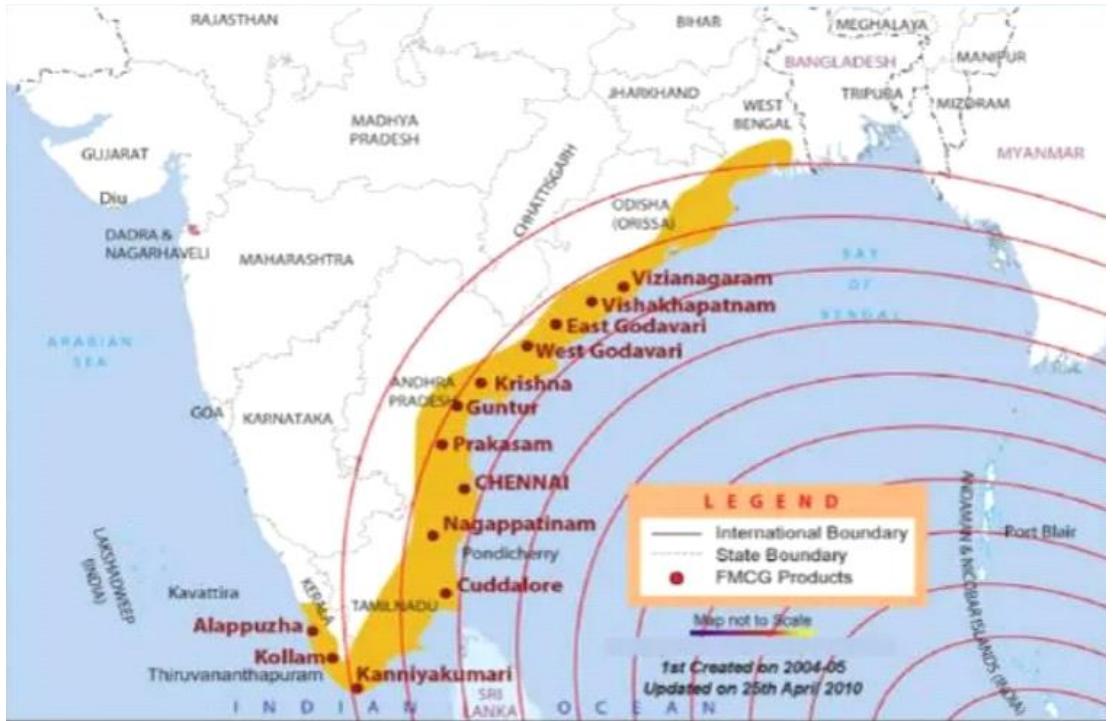
- How Energy moves the sea :



- Impact of Tsunami

- Loss of lives
- Damage to infrastructure
- Degradation of natural resources
- Loss of livelihood for farmers and fishermen
- Ecological impact

Indian Zones	<ul style="list-style-type: none"> • Entire coast is vulnerable • East coast is more vulnerable -> closeness to Pacific Ring of fire
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Mitigation Tsunami	<ul style="list-style-type: none"> • Early warning System : INCOIS Hyderabad <ul style="list-style-type: none"> • Tsunami early warning system – <ol style="list-style-type: none"> i. The Indian Tsunami Early Warning System was established in 2007 and is operated by INCOIS, Hyderabad. ii. It comprises a real-time network of seismic stations, tide gauges and a 24X7 operational tsunami warning centre to detect tsunamigenic earthquakes, to monitor tsunamis and to provide timely advisories to vulnerable communities. iii. It can detect large undersea earthquakes in the Indian Ocean in real-time and provide a tsunami warning in 10-20 minutes after the earthquake occurs. iv. Intergovernmental Oceanographic Commission (IOC) of UNESCO accredited Indian Tsunami Early Warning Centre (ITEWC) as Tsunami Service Provider (TSP) for 28 Indian Ocean Rim countries, along with Indonesia and Australia in 2011, for issuing regional warnings. • Management : <ul style="list-style-type: none"> • Natural buffers • Land use planning • Construction of embankment & barriers • Tsunami shelters • Insurance

L5 Epidemic, Fire, Industrial, CBRN

05 July 2025 12:31 AM

EPIDEMIC	<ul style="list-style-type: none">• Outbreaks of infectious diseases caused by pathogen (Bacteria / Fungus / Virus)<ul style="list-style-type: none">• High Mortality rate + High rate of transmission• Epidemic : Small or few countries• Pandemic : Global or Multiple countries<ul style="list-style-type: none">• An epidemic is the rapid spread of infectious disease to a large number of people in a given population within a short period of time.• A pandemic is defined as “an epidemic occurring over a very wide area, crossing international boundaries, and usually affecting a large number of people”.• WHO : Declares the breakout of Epidemic / Pandemic• Factors :<ul style="list-style-type: none">• Immunity : Natural protection against pathogens• Virulence : Severity of diseases +• Ro : Reproductive rate -> Number of person affected by 1 diseased person• Vectors : carrier and host• Reservoir host : Animals / Insects. : Like bats + birds + Mosquitoes• Mobility: speed and volume of global spread• Socio-cultural factors : contacts like Unsafe sex, Aerial transmission• Drug resistance : Self-medication and over medication reduce effectiveness• Climate change
Mitigating Epidemic	<ul style="list-style-type: none">• Preparedness and Mitigation measure :<ul style="list-style-type: none">• Early warning system for outbreak detection• Regular disease surveillance, random disease testing• Sanitation, Hygiene and Public health infrastructure• Quarantine protocols facilities and R&D• Environment conservation• Health insurance and Welfare measures• Response measures :<ul style="list-style-type: none">• Risk communication : Transparent and blocking spread of fake news• Testing, Tracing and Isolation : Arrest diseased to stop spreading• Social distancing, Lock down and Engaging communities : Buy Time for healthcare• Treating patients and protecting the health workforce

FOREST FIRES	<ul style="list-style-type: none">• Burning of Forest -> Wild Fires• Causes and Factors<ul style="list-style-type: none">Natural causes<ul style="list-style-type: none">• Lightning and thunderstorms• Heat waves• Volcanos• Invasive alien species
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Anthropogenic causes

- Shifting cultivation
- Clearing of land to collect minor forest produce
- Burning of crop residue
- Fires started deliberately by contractors & industries
- Land grabbing
- Poaching and illegal trade
- Exploitative Tourism

Impacts :

- Loss of lives and livelihood, Biodiversity
- Soil erosion, Landslides and Floods
- Global warming and climate change

Indian Zone

- About 21.4 % of forest cover in India is prone to fires,
- With forest in the North Eastern region and central India being the most vulnerable

Forests on FIRE

Over 10,634 incidents of forest fire have been reported between April 1 and May 2, 2016. This is five times more than what was reported during the same period last year

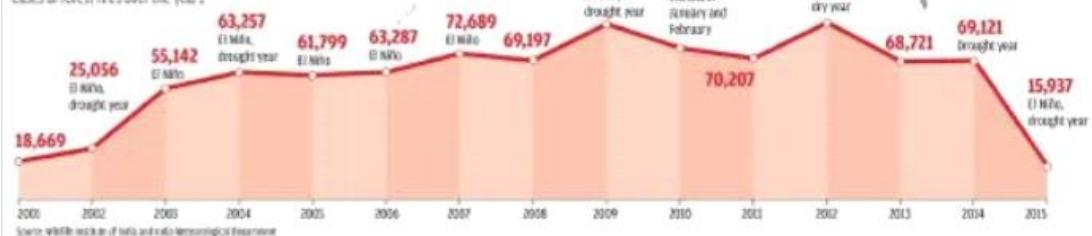
● Number of forest fires between April 1 and May 2, 2016
● Forest areas in India

50 per cent
of forests in India are
vulnerable to fire

₹440 cr
is India's annual loss due
to forest fires

Burning red

Cases of forest fires over the years



Mitigation

- Studies of Hazard

of Fire

- Risk assessment
- Early warning system
- Creation of forest fire lines
- Awareness generation
- Land use planning
- Natural buffers
- Strengthening the fire fighting capabilities
- Climate change mitigation

MAN MADE DISASTER	
Industrial Disasters	<ul style="list-style-type: none">• Bhopal Gas Tragedy (1984):<ul style="list-style-type: none">• Methyl isocyanate gas leak from Union Carbide plant killed thousands.• Vizag Gas Leak (2020):<ul style="list-style-type: none">• Styrene gas leak from LG Polymers plant in Visakhapatnam caused multiple deaths and hospitalizations.• Chasnala Mining Disaster (1975) :<ul style="list-style-type: none">• Coal mine collapse and flooding in Jharkhand killed 375 workers.• Korba Chimney Collapse (2009) :<ul style="list-style-type: none">• Under-construction power plant chimney in Chhattisgarh collapsed, killing 45 workers.• Jaipur Oil Depot Fire (2009) :<ul style="list-style-type: none">• IOC oil depot fire killed 12 and caused widespread environmental damage.• Mundra Port Ammonia Leak (2021) :<ul style="list-style-type: none">• Ammonia gas leak in Gujarat injured several workers...• Sterlite Copper Plant Protest & Firing (2018) :<ul style="list-style-type: none">• Environmental protests against pollution led to police firing and 13 deaths.• Bhilai Steel Plant Blast (2018) :<ul style="list-style-type: none">• Gas pipeline explosion killed 13 workers in Chhattisgarh.• NTPC Boiler Blast (2017) :<ul style="list-style-type: none">• Boiler explosion in Uttar Pradesh's Unchahar plant killed 43 people.• GAIL Pipeline Explosion (2014) :<ul style="list-style-type: none">• Gas leak and fire in Andhra Pradesh killed 23 villagers.• Factors causing disasters<ul style="list-style-type: none">• Natural hazards : Caused by earthquake, floods, Tsunami• Technical failure : accidental or negligence for cutting cost• Lack of SOP compliance : High temp, pressure industries, Chemicals and toxics used• Sabotage or Terrorism• Poor maintenance• Relevant Law :

Following are the relevant laws containing provisions related to industrial disaster management, prevailing in the country:-

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Explosives Act 1884 3. Factories Act 1948 5. Environment Protection Act 1986 7. Public Liability Insurance Act 1991 | <ol style="list-style-type: none"> 2. Petroleum Act 1934 4. Insecticides Act 1968 6. Motor Vehicles Act 1988 8. Disaster Management Act 2005 |
|---|--|

CBRN	<ul style="list-style-type: none"> • CBRN : Chemical, Biological, Radiological and Nuclear Disaster • More wider impact, civilian masses hit • Causes : War or Terrorism • Chemical Disasters <ul style="list-style-type: none"> • Bhopal Gas Tragedy, India (1984): MIC gas leak from Union Carbide killed over 15,000 people. • Seveso Disaster, Italy (1976): Dioxin gas leak from a chemical plant caused mass evacuations and health issues. • Halabja Chemical Attack, Iraq (1988): Saddam Hussein's forces used chemical weapons, killing over 5,000 Kurds. • Beirut Ammonium Nitrate Blast, Lebanon (2020): Massive explosion killed 200+ and injured thousands. • Biological Disasters : Banned by International <ul style="list-style-type: none"> • COVID-19 Pandemic (2019–present): Global pandemic caused by SARS-CoV-2, affecting millions worldwide. • Anthrax Attacks, USA (2001): Letters containing anthrax spores sent to U.S. media and politicians, killing 5. • Sverdlovsk Anthrax Leak, USSR (1979): Accidental release of anthrax spores from a military facility, killing dozens. • Ebola Outbreak, West Africa (2014–2016): Viral epidemic killed over 11,000 people. • Radiological Disasters <ul style="list-style-type: none"> • Goiania Accident, Brazil (1987): Cesium-137 from medical equipment caused severe radiation poisoning. • Tokaimura Nuclear Accident, Japan (1999): Improper handling of uranium caused fatal radiation exposure. • Mayapuri Radiological Accident, India (2010): Cobalt-60 found in scrap yard caused radiation injuries. • Nuclear Disasters <ul style="list-style-type: none"> • Chernobyl Disaster, USSR (1986): Reactor explosion led to widespread radioactive contamination across Europe. • Fukushima Daiichi Nuclear Disaster, Japan (2011): Earthquake-triggered meltdown caused nuclear crisis. • Three Mile Island Incident, USA (1979): Partial reactor meltdown in Pennsylvania, worst U.S. nuclear accident.
INES	<ul style="list-style-type: none"> • International Nuclear and Radiology Event Scale • Scale to mark magnitude of Nuclear accident

	<ul style="list-style-type: none"> • “Tool for communicating the safety significance of nuclear and radiological events to the public.” • Developed in 1990 by the IAEA and the Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD-NEA)
Impact of Manmade Disasters	<ul style="list-style-type: none"> • No Zoning : Poor Planning -> Industrial corridor present near residential area • Human injury and loss of lives • Degradation of natural resources • Economic loss • Ecological degradation
Mitigating Man Made Disaster	<ul style="list-style-type: none"> • Identifying Hazardous industries + Zoning <ul style="list-style-type: none"> • Early warning • Land use planning • Adoption of fail safe design • Multi layer safety system • Awareness • Legal liability framework • Random inspection by inspectorates and stringent punishment for violators • Specialized Response: Rescue and relief, Contamination control, Medical aid

L6 UN Convention

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UN and Disaster	
Important Development	<ul style="list-style-type: none"> Under UN Charter include welfare, maintain peace, Humanitarian situation and environment After Stockholm -> started focus on Disaster UNDRO established, 1990s Decade for Disaster Japan being most effected -> Global leader for disaster management <ul style="list-style-type: none"> During 1960's UNGA adopted measures regarding severe disasters 1970 – 1986: Assistance in case of Natural Disaster UNDRO - United Nations Disaster Reduction Office was set up 1990 – 1999: International Decade for Natural Disaster Reduction 1993: UNGA decided to convene World Conference on Disaster Reduction
World Conference	<ul style="list-style-type: none"> Hosted by Japan, Under UN <ul style="list-style-type: none"> 1999 -> end of Disaster Decade -> UNISDR created to focus on Management and assist UNISDR -> UNDRR The World Conference on Disaster Reduction is a series of United Nations conferences focusing on disaster and climate risk management in the context of sustainable development. The World Conference has been convened three times, with each edition to date having been hosted by Japan: Yokohama in 1994, Hyogo in 2005 and Sendai in 2015. The UN General Assembly adopted the International Strategy for Disaster Reduction in 1999 and established the United Nations Office for Disaster Risk Reduction (UNDRR, formerly UNISDR), as the secretariat to ensure its implementation. Its mandate was expanded in 2001 to serve as the focal point in the United Nations system to ensure coordination and synergies among disaster risk reduction activities of the United Nations system. As requested by the UN General Assembly, the UNDRR served as the coordinating body for the Second and Third UN World Conference on Disaster Reduction in 2005 and 2015. 3 world conferences yet : Yokohama 1994, Hyogo 2005, Sendai 2015 <ul style="list-style-type: none"> i. Yokohama Strategy and Plan of Action for a Safer World in 1994 ii. Hyogo Framework for Action (2005-2015) iii. Sendai Framework for DRR (2015-2030)
Yokohama 1994	<ul style="list-style-type: none"> Yokohama Strategy and Plan for Action for a Safer World in 1994 <ul style="list-style-type: none"> Action plan for 1994-2004. 10 Principles for DM Cycle

The ten principles of the Yokohama Strategy for a Safer World:

- 1) Risk assessment is a required step for the adoption of adequate and successful disaster reduction policies and measures.
- 2) Disaster prevention and preparedness are of primary importance in reducing the need for disaster relief.
- 3) Disaster prevention and preparedness should be considered integral aspects of development policy and planning at national, regional, bilateral, multilateral and international levels.
- 4) The development and strengthening of capacities to prevent, reduce and mitigate disasters is a top priority area to be addressed during the decade so as to provide a strong basis for follow-up activities to the decade.
- 5) Early warnings of impending disasters and their effective dissemination using telecommunications, including broadcast services, are key factors to successful disaster prevention and preparedness.
- 6) Preventive measures are most effective when they involve participation at all levels, from the local community through the national government to the regional and international level.
- 7) Vulnerability can be reduced by the application of proper design and patterns of development focused on target groups, by appropriate education and training of the whole community.
- 8) The international community accepts the need to share the necessary technology to prevent, reduce and mitigate disaster; this should be made freely available and in a timely manner as an integral part of technical cooperation.
- 9) Environmental protection as a component of sustainable development consistent with poverty alleviation is imperative in the prevention and mitigation of natural disasters.
- 10) Each country bears the primary responsibility for protecting its people, infrastructure, and other national assets from the impact of natural disasters. The international community should demonstrate strong political determination required to mobilize adequate and make efficient use of existing resources, including financial, scientific and technological means, in the field of natural disaster reduction, bearing in mind the needs of the developing countries, particularly the least developed countries.

- Shortcoming of Yokohama :

- No Specific Targets or deadline : Only priorities area given
- No detailed plan of Action: What ? How ?
- No focus of post disaster management

- India participated, but didn't follow properly
- 2004 : until cyclone -> No framework

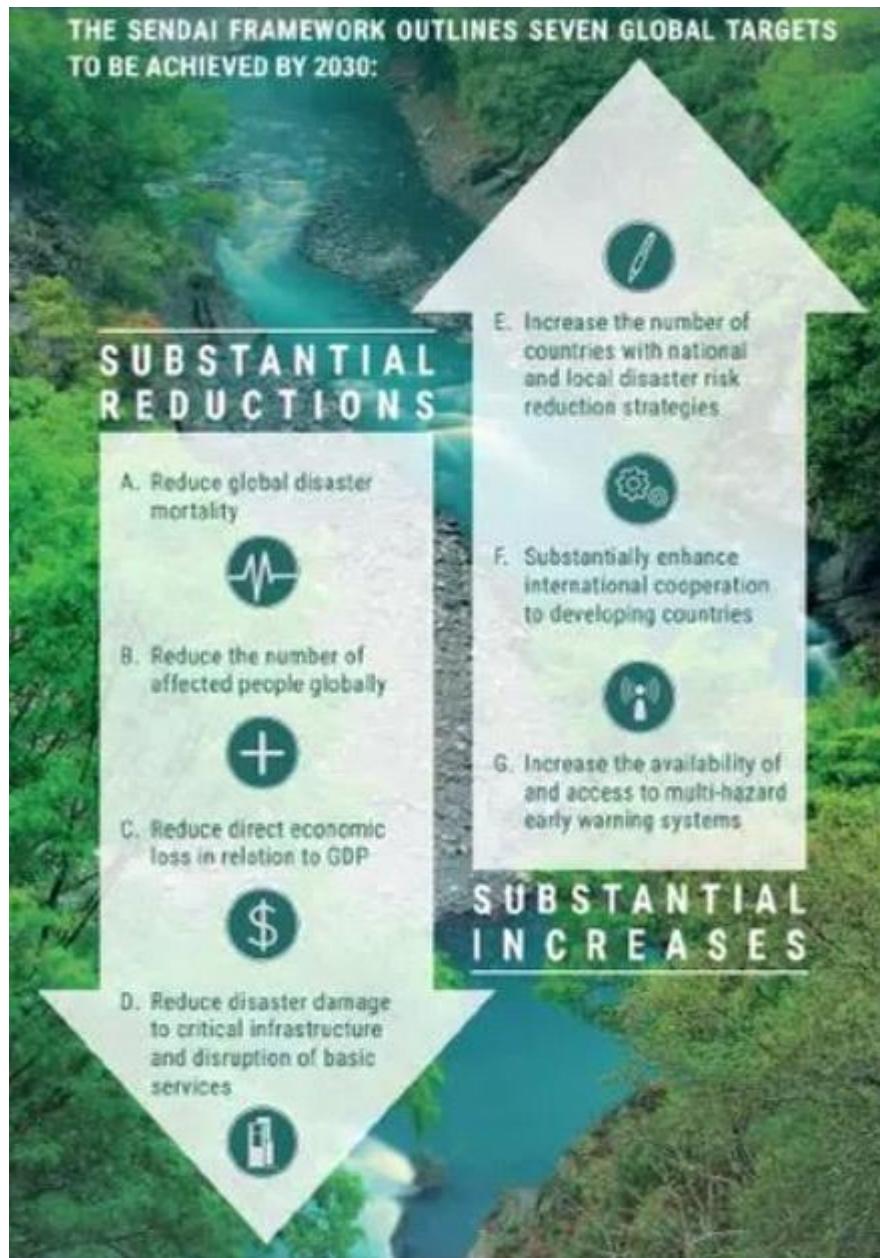
Hyogo
2005

- Hyogo Framework for Action 2005-2015
 - 2nd Conference : To replace Yokohama end in 2004
 - Updated -> 5 Specific focus area, Still no quantifiable target or goals.
 - Not legally binding
 - The Hyogo Framework for Action: Building the Resilience of Nations and Communities to Disasters was an outcome of the 2005 conference.
 - The Hyogo Framework (HFA) was the first plan to explain, describe and detail the work required from all different sectors and actors to reduce disaster losses. It was developed and agreed on with the many partners needed to reduce disaster risk – governments, international agencies, disaster experts and many others – bringing them into a common system of coordination. The HFA, which ran from 2005 to 2015, set five specific priorities for action:
 - 1) Making disaster risk reduction a priority
 - 2) Improving risk information and early warning
 - 3) Building a culture of safety and resilience
 - 4) Reducing the risks in key sectors
 - 5) Strengthening preparedness for response

- Sendai Framework for Disaster Risk Reduction 2015-2030
 - MDG -> SGD, in line with SDG Targets, 15 year voluntary, non-binding agreement
 - Manage Hazard, reduce vulnerability and reduce exposure
 - Added Participation of local govt and private sector
- The Sendai Framework is a 15-year voluntary, non-binding agreement which recognizes that the State has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders including local government and the private sector. It aims for the following outcome:

"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."

 - The Sendai Framework emerged from three years of consultations and negotiations, supported and coordinated by UNDRR, during which UN member states, NGOs and other stakeholders made calls for an improved version of the existing Hyogo Framework, with a set of common standards, a comprehensive framework with achievable targets, and a legally-based instrument for disaster risk reduction.
 - Member states also emphasised the need to tackle disaster risk reduction and climate change adaption when setting the Sustainable Development Goals, particularly in light of an insufficient focus on risk reduction and resilience in the original Millennium Development Goals.
- 4 Priorities areas :
 - Research + mainstreaming disaster risk Governance
 - Finance (Budgetary before disaster) + Phases (Prepare + Response + Build Back)
- The Sendai Framework sets four specific priorities for action:
 1. Understanding disaster risk
 2. Strengthening disaster risk governance to manage disaster risk
 3. Investing in disaster risk reduction for resilience
 4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction
- 7 Specific Targets with Deadline :
 - Reducing mortality + affected people + economic loss + critical infra damage
 - Risk Reduction Strategies creation + Mutli hazard early warning System
 - International cooperation
- To support the assessment of global progress in achieving the outcome and goal of the Sendai Framework, seven global targets have been agreed:
 1. Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020–2030 compared to 2005–2015.
 2. Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020–2030 compared to 2005–2015.
 3. Reduce direct disaster economic loss in relation to global gross domestic product by 2030.
 4. Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030.
 5. Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
 6. Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the framework by 2030.
 7. Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.



UN SPIDER	<ul style="list-style-type: none"> • UN Space based information for Disaster management and Emergency Response : <ul style="list-style-type: none"> • Uninterrupted Communication + Satellite data to reconstruct • Not every country can afford -> UN Global platform to share • Country leading : US + China + EU + India • United Nations Platform for Space-based Information for Disaster Management and Emergency Response. • "Ensure that all countries and international and regional organizations have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle".
MCR 2030	<ul style="list-style-type: none"> • Making Cities Resilient 2030 : Under SDG 11 • Share initiative and helping in research and administration • C40 : Making 40 cities resilient around the world

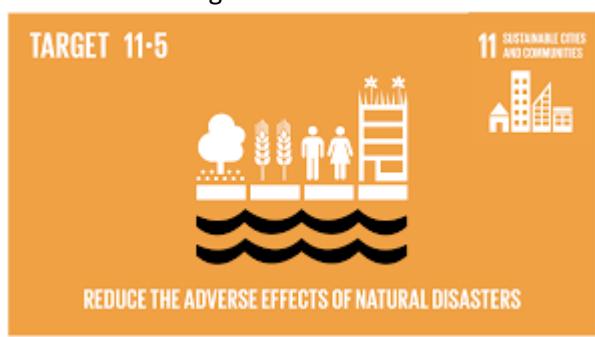
About Making Cities Resilient 2030

Is your city resilient? Does its resilience help its citizens to prosper and flourish? Join other cities on a pathway to resilience – making the city safer, preventing risks and promoting innovation and investments.

Making Cities Resilient 2030 (MCR2030) is a unique cross-stakeholder initiative for improving local resilience through advocacy, sharing knowledge and experiences, establishing mutually reinforcing city-to-city learning networks, injecting technical expertise, connecting multiple layers of government and building partnerships.

Through delivering a clear 3-stage roadmap to urban resilience, providing tools, access to knowledge and monitoring and reporting tools, MCR2030 will support cities on their journey to reduce risk and build resilience.

MCR2030 aims to ensure cities become inclusive, safe, resilient and sustainable by 2030, contributing directly to the achievement of Sustainable Development Goal 11 (SDG11) "Make cities and human settlements inclusive, safe, resilient and sustainable", and other global frameworks including the Sendai Framework for Disaster Risk Reduction, the Paris Agreement and the New Urban Agenda.

SDG 11	<ul style="list-style-type: none">SDG 11.5 focuses on reducing the adverse effects of natural disasters by significantly reducing the number of deaths and people affected, and substantially decreasing direct economic losses relative to global GDP. 

L7 Indian Framework

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INDIAN FRAMEWORK	
Events	<ul style="list-style-type: none">• Mega Disaster occurred in India<ul style="list-style-type: none">• 1999 : Super Cyclone in Odisha• 2001 : Bhuj Earthquake Gujarat• 2004 : Indian Ocean region tsunami• After several events India adopted following :<ul style="list-style-type: none">• 2005 : Disaster Management Act DMA<ul style="list-style-type: none">◦ After Yokohama and Hyogo• 2009 : National Disaster Management Policy NDMA• 2016 : National Disaster Management Plan NDMP<ul style="list-style-type: none">◦ Inline to Sendai Framework
DMA 2005	<ul style="list-style-type: none">• Disaster Management Act 2005<ul style="list-style-type: none">• Paradigm Shift : Adhoc -> pro active<ul style="list-style-type: none">• The Act lays down institutional, legal, financial and coordination mechanisms at the National, State, District and Local levels.• These institutions are not parallel structures and will work in close harmony.• The new institutional framework is expected to usher in a paradigm shift in DM from relief-centric approach to a proactive regime that lays greater emphasis on preparedness, prevention and mitigation.• This act envisaged a three tier structure for Disaster Management in India at the National, States and District levels.• 9 Institution created under the ACT :<ul style="list-style-type: none">• 3 tier : NDMA + SDMA + DDMA• Executive committee : Nec +SEC• Response : NDRF + SDRF• Finance : Response Fund + Mitigation Fund (++ State level)• Institute : NIDM (Training and R&D)<ul style="list-style-type: none">1. National Disaster Management Authority2. State Disaster Management Authority3. District Disaster Management Authority4. National Executive Committee5. State Executive Committee6. National Disaster Response Force7. National Disaster Response Fund8. National Disaster Mitigation Fund9. National Institute of Disaster Management
NDMA	<ul style="list-style-type: none">• National Disaster Management Authority :<ul style="list-style-type: none">• Nodal Authority : Highest decision making body<ul style="list-style-type: none">◦ Develop and adopt National Policy, plans and guidelines -> Completed in 2009◦ Develop National Executive Committee -> Completed in 2016• Currently : Recommend + Command NDRF + guide NIDM

- The NDMA has the **Prime Minister** as its ex-officio chairperson.
- Further, it has a **maximum of nine members** nominated by Chairman (Prime Minister).
- The Chairman can nominate any of the nine members also as **Vice-chairman** of NDMA.

Powers and Functions of NDMA

- The key responsibilities of NDMA include laying down the **policies, plans and guidelines** for disaster management for ensuring timely and effective response to disaster.
- It lays down the **National Policy on Disaster Management**, approve the **National Plan for Disaster Management**, and approve plans developed by various ministries of the union, lay down the **guidelines to be followed by the state authorities** in drawing up state plans.
- NDMA also is mandated to **recommend guidelines** for the **minimum standards of relief** to be provided to persons affected by disaster.
- The **general superintendence, direction and control** of the **National Disaster Response Force (NDRF)** is vested in and will be exercised by the NDMA.
- The **National Institute of Disaster Management (NIDM)** works within the framework of broad policies and guidelines laid down by the NDMA.

- Nodal Ministry : MHA -> DM Diction
 - Manages Centre State coordination

NEC

- National Executive Committee :
 - Implementation and execution planed according to NDMA.
 - The **NEC is the executive committee of the NDMA**, and is mandated to assist the NDMA in the discharge of its functions and also ensure compliance of the directions issued by the Central Government.
 - The NEC comprises the **Union Home Secretary as Chairperson**, and the Secretaries to the GoI in the Ministries/Departments of Agriculture, Atomic Energy, Defence, Drinking Water Supply, Environment and Forests, Finance (Expenditure), Health, Power, Rural Development, Science & Technology, Space, Telecommunications, Urban Development, Water Resources and the Chief of the Integrated Defence Staff of the Chiefs of Staff Committee as members. Secretaries in the Ministry of External Affairs, Earth Sciences, Human Resource Development, Mines, Shipping, Road Transport & Highways, and the Secretary, NDMA will be special invitees to the meetings of the NEC.

- Role of NEC :

- Building coordination between different Minister, Centre and State
- DC can call Armed Forces for assistance at time of Disaster
- Ensuring Implementation

- The NEC had to **prepare the National Plan for Disaster Management** based on the National Policy on Disaster Management.

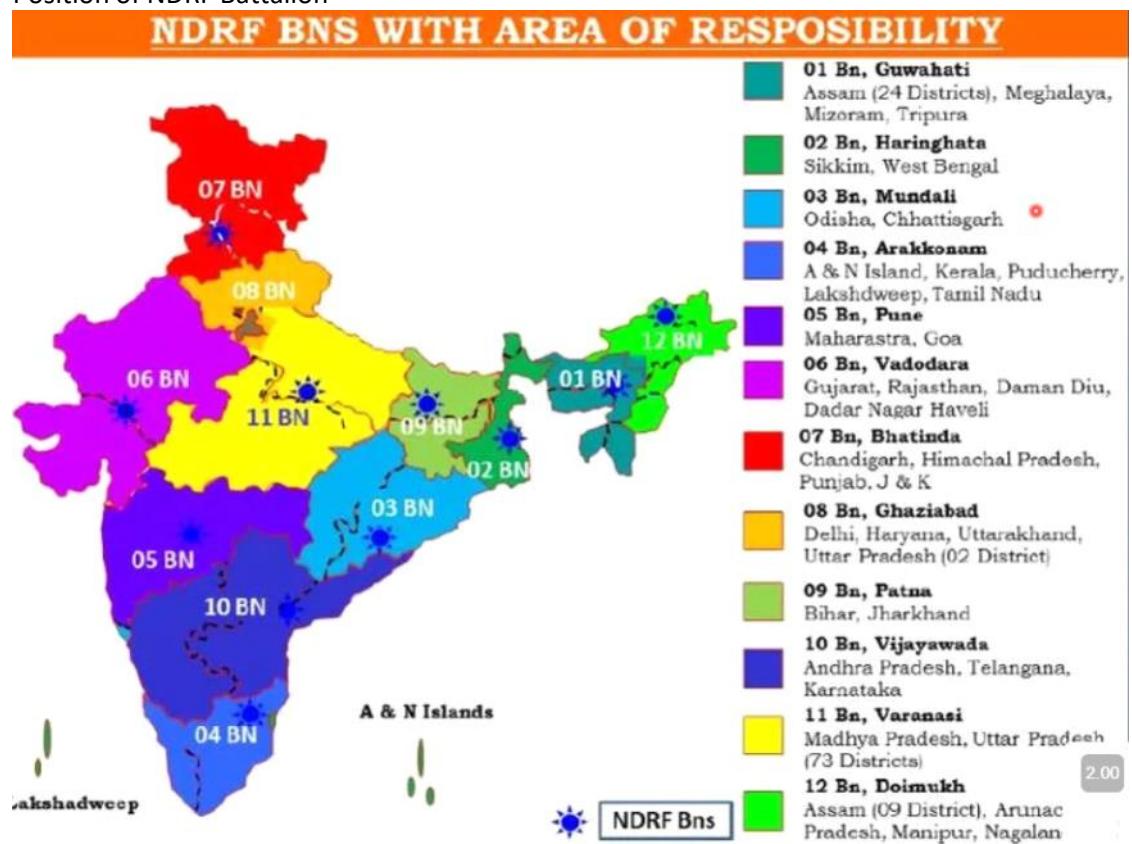
Powers and Functions of NEC

- Assist **NDMA** in its functions.
- Implementing the plans and policies of NDMA.
- Ensuring compliance with the directives of Central Government.
- To act as a coordinating and monitoring body for disaster management.
- Prepare the National Plan to be approved by the NDMA.
- Prepare guidelines for different ministries with respect to disaster management.
- Provide technical assistance to state governments and authorities.
- Monitor the implementation of the National Plans and plans of various ministries Monitor implementation of the guidelines laid down by the NDMA.
- Coordinate response in case of a disaster.
- Advise and assist various ministries and departments.

SDMA and SEC	<ul style="list-style-type: none"> • SDMA : State Disaster Management Authority : <ul style="list-style-type: none"> • State Policy inline within National Policy ◦ Created by State Executive Committee • At the State level, the SDMA, headed by the Chief Minister, will lay down policies and plans for DM in the State. • It will, inter alia approve the State Plan in accordance with the guidelines laid down by the NDMA. • Coordinate the implementation of the State Plan. • Recommend provision of funds for mitigation and preparedness measures. • Review the developmental plans of the different Departments of the State to ensure the integration of prevention, preparedness and mitigation measures. <ul style="list-style-type: none"> • SEC State Executive Committee : <ul style="list-style-type: none"> • SEC prepare State plan -> Approved by SDMA -> SEC Implement guideline • Headed by Chief Secretary : highest power in State Administration • The State Government shall constitute a State Executive Committee (SEC) to assist the SDMA in the performance of its functions. • The SEC will be headed by the Chief Secretary to the State Government and coordinate and monitor the implementation of the National Policy, the National Plan and the State Plan. • The SEC will also provide information to the NDMA relating to different aspects of DM.
DDMA	<ul style="list-style-type: none"> • DDMA District Disaster Management Authority : <ul style="list-style-type: none"> • Most important -> Implement on the ground level • Headed by DC District collector • The DDMA will be headed by the District Collector, Deputy Commissioner or District Magistrate as the case may be, with the elected representative of the local authority as the Co-Chairperson. • The DDMA will act as the planning, coordinating and implementing body for DM at the District level and take all necessary measures for the purposes of DM in accordance with the guidelines laid down by the NDMA and SDMA. • It will, inter alia prepare the District DM plan for the District and monitor the implementation of the National Policy, the State Policy, the National Plan, the State Plan and the District Plan. • The DDMA will also ensure 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.
NDRF	<ul style="list-style-type: none"> • NDRF National Disaster Response Force <ul style="list-style-type: none"> • SAR Ops -> Specialised Response Force • CAPRFs (under MHA) -> Special Training -> NDRF • NDRF : 12 Battalions (3 from BSF + CRPF and 2 from CISF + ITBP + SSB) • Self Contained units (No support required) + Equipped with special tools

- For the purpose of specialised response to a threatening disaster situation or disasters/emergencies both natural and man-made such as those of CBRN origin, the Act has mandated the constitution of a National Disaster Response Force (NDRF).
- The general superintendence, direction and control of this force shall be vested in and exercised by the NDMA and the command and supervision of the Force shall vest in an officer to be appointed by the Central Government as the Director General of Civil Defence and National Disaster Response Force.
- In 2006, NDRF was constituted with 8 Battalions. At present, NDRF has a strength of 12 Battalions with each Battalion consisting of 1149 personnel..
- The practice of “proactive availability” of this force to the States and that of “pre-positioning”, in a threatening disaster situations have immensely helped minimise damage, caused due to natural calamities in the country.
- At present, National Disaster Response Force consist of 12 battalions, three each from the BSF and CRPF and two each from CISF, ITBP and SSB.
- Each battalion have 18 self-contained specialist search and rescue teams of 45 personnel each including engineers, technicians, electricians, dog squads and medical/paramedics.
- All the 12 battalions have been equipped and trained to respond natural as well as man-made disasters. Battalions are also trained and equipped for response during chemical, biological, radiological and nuclear (CBRN) emergencies.

- Position of NDRF Battalion



NIDM

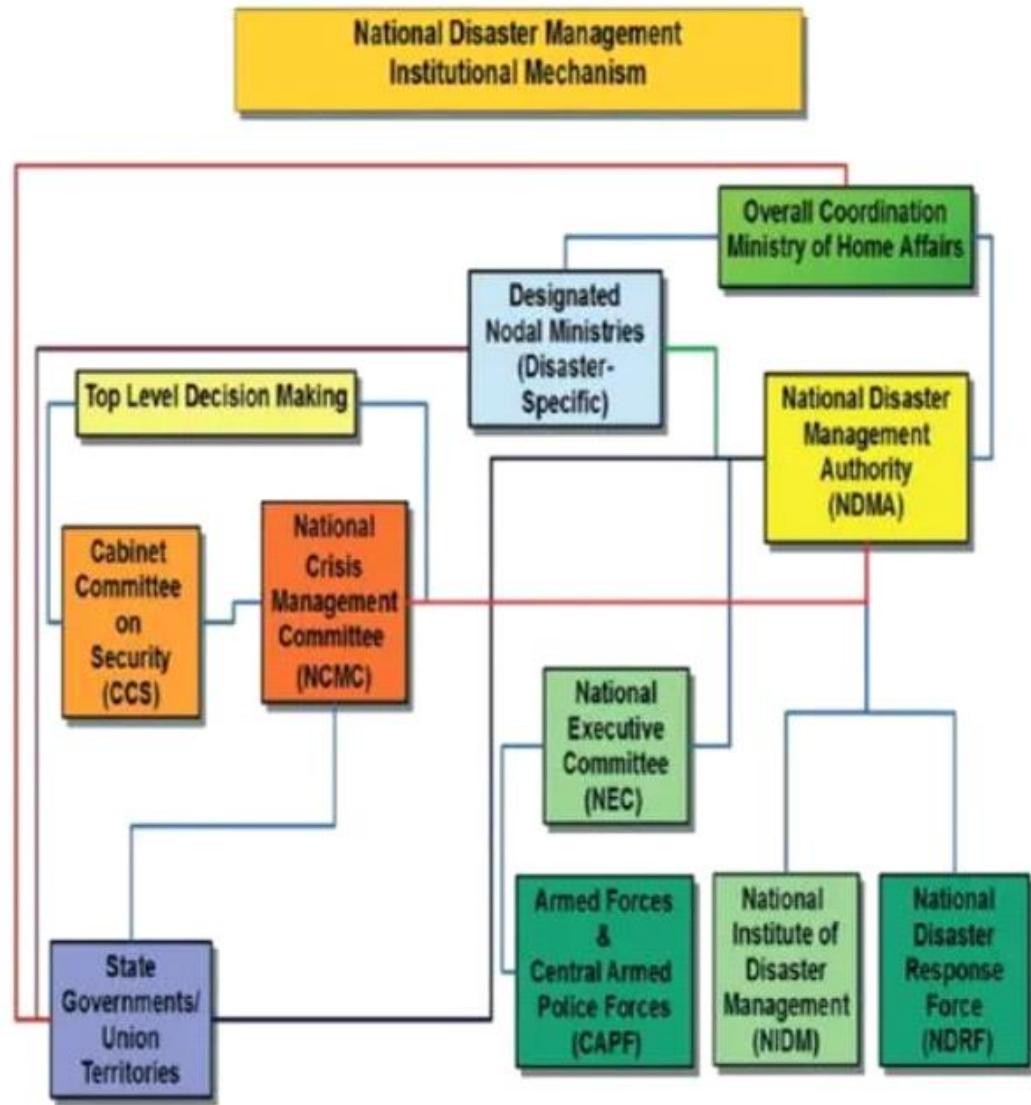
- NIDM : National Institute of Disaster Management

- The NIDM, in partnership with other research institutions has capacity development as one of its major responsibilities, along with training, research, documentation and development of a National level information base.
- It will network with other knowledge-based institutions and function within the broad policies and guidelines laid down by the NDMA.
- It will organise training of trainers, DM officials and other stakeholders.
- The NIDM will strive to emerge as a ‘Centre of Excellence’ in the field of Disaster Management.

Organisation

- Different bodies and their coordination

Schematic



- National Level Decision Making Bodies :

Table 1-3: Key national-level decision-making bodies for disaster management

	Name	Composition	Vital role
1	Cabinet Committee on Security (CCS)	Prime Minister, Minister of Defence, Minister of Finance, Minister of Home Affairs, and Minister of External Affairs	<ul style="list-style-type: none"> Evaluation from a national security perspective, if an incident has potentially security implications Oversee all aspects of preparedness, mitigation and management of Chemical, Biological, Radiological and Nuclear (CBRN) emergencies and of disasters with security implications Review risks of CBRN emergencies from time to time, giving directions for measures considered necessary for disaster prevention, mitigation, preparedness and effective response
2	National Crisis Management Committee (NCMC)	<ul style="list-style-type: none"> Cabinet Secretary (Chairperson) Secretaries of Ministries / Departments and agencies with specific DM responsibilities 	<ul style="list-style-type: none"> Oversee the Command, Control and Coordination of the disaster response Give direction to the Crisis Management Group as deemed necessary Give direction for specific actions to face crisis situations
3	National Disaster Management Authority (NDMA)	<ul style="list-style-type: none"> Prime Minister (Chairperson) Members (not exceeding nine, nominated by the Chairperson) 	<ul style="list-style-type: none"> Lay down policies, plans and guidelines for disaster management Coordinate their enforcement and implementation throughout the country Approve the NDMP and the DM plans of the respective Ministries and Departments of Government of India Lay down guidelines for disaster management to be followed by the different Central Ministries, Departments and the State Governments
4	National Executive Committee (NEC)	<ul style="list-style-type: none"> Union Home Secretary (Chairperson) Secretaries to the GOI in the Ministries / Departments of Agriculture, Atomic Energy, Defence, Drinking Water and sanitation, Environment, Forests and Climate Change, Finance (Expenditure), Health and Family Welfare, Power, Rural Development, Science and Technology, Space, Telecommunications, 	<ul style="list-style-type: none"> To assist the NDMA in the discharge of its functions Preparation of the National Plan Coordinate and monitor the implementation of the National Policy Monitor the implementation of the National Plan and the plans prepared by the Ministries or Departments of the Government of India Direct any department or agency of the Govt. to make available to the NDMA or SDMAs such men, material or resources as are available with it for the purpose of emergency response, rescue and relief Ensure compliance of the directions issued by the Central Government Coordinate response in the event of any threatening disaster situation or disaster Direct the relevant Ministries / Departments of the GoI, the State Governments and the SDMAs regarding measures to be taken in response to

Agency for warning

- Central Agency Designated for natural Hazard Specific Early Warnings :

Hazard	Agencies
1 Avalanches	Snow and Avalanche Study Establishment (SASE)
2 Cyclone	India Meteorological Department (IMD)
3 Drought	Ministry of Agriculture and Farmers Welfare (MoAFW)
4 Earthquake	India Meteorological Department (IMD)
5 Epidemics	Ministry of Health and Family Welfare (MoHFW)
6 Floods	Central Water Commission (CWC)
7 Landslides	Geological Survey of India (GSI)
8 Tsunami	India National Centre for Oceanic Information Services (INCOIS)

Funding management

- National Disaster Response Fund :
 - Only used for emergency relief and rescue : During disaster
 - NDRF : National -> Mobilised through budget (taxes raised) (Centre)
 - SDRF : State -> Recommendation to Finance Commission (State + Centre)

- The National Disaster Response Fund (NDRF), constituted under **Section 46 of the Disaster Management Act, 2005**, supplements SDRF of a State, in case of a disaster of severe nature, provided adequate funds are not available in SDRF.
- The **Government of India supplements the effort of the State Government** by providing assistance for relief of immediate nature through two ways:
 - i. State Disaster Response Fund (SDRF)
 - ii. National Disaster Response Fund (NDRF)
- The allocation of funds under SDRF and NDRF is based on the **recommendations of the Financial Commission**.
- In **NDRF**, the entire contribution in the fund comes from the **Central Government**.

- **SDRF : State Disaster Response Fund :**
 - Primary responsibility to provide relief
 - Centre supplement 75 % from NDRF Funds, and 90% in Special States
 - Once SDRF fund is exhausted -> NDRF Fund is used
- The State Disaster Response Fund (SDRF), constituted under **Section 48 of the Disaster Management Act, 2005**, is the **primary fund available with State Governments** for responses to notified disasters.
- The Central Government contributes **75%** of SDRF allocation for **general category States/UTs** and **90% for special category States/UTs** (NE States, Sikkim, Uttarakhand, Himachal Pradesh, Jammu and Kashmir).
- The annual Central contribution is released in **two equal installments** as per the **recommendation of the Finance Commission**.
- SDRF shall be **used only for meeting the expenditure for providing immediate relief** to the victims.
- **Disasters covered under SDRF:** Cyclone, drought, earthquake, fire, flood, tsunami, hailstorm, landslide, avalanche, cloudburst, pest attack, frost and cold waves.
- **Local Disaster:** A State Government may use up to **10% of the funds** available under the SDRF for providing immediate relief to the victims of natural disasters that they consider to be 'disasters' within the local context in the State and which are **not included in the notified list of disasters of the Ministry of Home Affairs** subject to the condition that the State Government has listed the State specific natural disasters and notified clear and transparent norms and guidelines for such disasters with the approval of the State Authority, i.e., the State Executive Authority (SEC).

- **NDMF National Disaster Mitigation Fund**
 - Mitigation Fund : Only to be used before Disaster
 - SDMF for State Mitigation
- **15th Finance Commission**, in its report had made recommendations for setting up Mitigation Funds and suggested allocations at National and State level.
- Central Government had **constituted the National Disaster Mitigation Fund (NDMF)** in **2021** and also **advised all the State Governments** to set up State Disaster Mitigation Fund (SDMF) in the State.
- So far, **all the States**, except Telangana, have intimated setting up of SDMF.
- For the **first time allocation of funds, exclusively for the mitigation of disaster risks**, has been made by the Government, both at national and state level.
- Central Government contributes **75% for all States (90% for North-Eastern and Himalayan States)** as Centre share in SDMF.
- For allocation of mitigation funds, **15th Finance Commission recommended a new methodology** which is a combination of capacity (as reflected through past expenditure), risk exposure (area and population) and proneness to hazard and vulnerability (disaster risk index).

- **NDRMF National Disaster Risk Management Fund**

- Combined NDRMF = NDMF + NDRF
- To reduce wastage and overlap
- 80% for Response + 2% for mitigation
- The coverage of the funds recommended by **15th Finance Commission** goes beyond the disaster response funds that already exist at the national (NDRF) and state (SDRF) levels. Hence, 15th Finance Commission has recommended the creation of funds for disaster mitigation along with disaster response, which will now together be called **National Disaster Risk Management Fund (NDRMF)** and **State Disaster Risk Management Funds (SDRMF)**.
- The Commission has also recommended an allocation of Rs. 1,60,153 crores in the SDRMF for the years 2021-26, out of which Rs. 1,28,122 crore (80% of SDRMF) is for State Disaster Response Fund and Rs. 32,031 crore (20% of SDRMF) is for State Disaster Mitigation Fund.
- Similarly, an amount of Rs. 68,463 crore has been allocated for NDRMF for the period of 2021-22 to 2025-26 out of which Rs. 54,770 crore (80% of NDRMF) is for National Disaster Response Fund and Rs. 13,693 crore (20% of NDRMF) is for National Disaster Mitigation Fund.

• Recommendation for projects :

- The **15th Commission** has recommended “earmarked allocation” from **NDRF** for two activities:
 - Expansion and Modernization of **Fire Services** (Rs. 5000 crore).
 - Resettlement of displaced people affected by **erosion** (Rs. 1000 crore).
- The **15th Commission** has recommended “earmarked allocation” from **NDMF** for four activities:
 - Catalytic assistance to 12 most **drought-prone States** (Rs. 1200 crore)
 - Managing **seismic** and **landslide risks** in 10 hill States (Rs. 750 crore)
 - Reducing the risk of **urban flooding** in 7 most populous cities (Rs. 2500 crore)
 - Mitigation measures to **prevent erosion** (Rs. 1500 crores)

• Responding to request for Central Assistance from States :

- State can request additional support after exhausting SDRF
- Condition : Proposal submit + Prove Calamity severe
- Point of conflict : between opposing power in centre and state
- The Government of India has established a **flexible response mechanism** for a prompt and effective delivery of essential services as well as resources to assist a **State Government or Union Territory** severely hit by a disaster.
- Disaster management is considered as the responsibility of the State Governments, and hence the **primary responsibility** for undertaking rescue, relief and rehabilitation measures during a disaster lies with the State Governments.
- The **Central Government supplements** their efforts through logistical and financial support during severe disasters as requested by the State Governments.
- Responding to such emergencies stretches the resources of district and State administration to the utmost and they may require and seek the assistance of Central Ministries/Departments and agencies like the NDRF, Armed Forces, CAPF, and Specialized Ministries/ Agencies.

- Providing financial assistance for disaster preparedness, restoration, reconstruction and mitigation in the event of a natural disaster are not part of National Disaster Response Fund's mandate.
- In the event of a **calamity of a severe nature**, where the requirement of funds for relief operations is **beyond the funds available in the State's State Disaster Response Fund account**, additional Central assistance is provided from National Disaster Response Fund, after following the laid down procedure.
- As per this procedure, the **State Government** is required to submit a **memorandum** indicating the **sector wise damage and requirement of funds**.
- On receipt of the memorandum from the State, an **Inter-Ministerial Central Team** is constituted and deputed to submit a report after an on the spot assessment of damage and requirement of funds for relief operations, as per the extant items and norms of State Disaster Response Fund and National Disaster Response Fund.
- The report of the Central Team is considered by the **Inter-Ministerial Group (IMG)/National Executive Committee (NEC)** headed by the **Home Secretary**.
- Thereafter, a **High Level Committee (HLC)** approves the quantum of immediate relief to be released from National Disaster Response Fund.
- The **Disaster Management Division of MHA** provides support to the HLC.
- The **MHA oversees the utilisation of funds** provided from the National Disaster Response Fund and monitors compliance with norms.

Accepting Foreign Funds	<ul style="list-style-type: none"> • Accepting foreign support : <ul style="list-style-type: none"> • Can we accept -> Yes, DM Act does not prohibit • Do we accept -> No, Convention following self sufficient • Express thanks for goodwill • As a matter of policy, the Government of India does not issue any appeal for foreign assistance in the wake of a disaster. • However, if the national government of another country voluntarily offers assistance as a goodwill gesture in solidarity with the disaster victims, the Central Government may accept the offer. • The Ministry of Home Affairs is required to coordinate with the Ministry of External Affairs, which is primarily responsible for reviewing foreign offers of assistance and channelizing the same. • In consultation with the concerned State Government, the MHA will assess the response requirements that the foreign teams can provide.
	<ul style="list-style-type: none"> • Accepting Multilateral Assistance : <ul style="list-style-type: none"> • Do we accept -> May be after MEA + MHA acceptance

	<ul style="list-style-type: none"> • In the case of an offer of assistance from UN Agencies, then India will accept the offer only if the government considers it necessary, based on various factors. • If accepted, GoI will issue directions to the respective Ministry or State Government to coordinate with the concerned UN agency. • Any financial assistance offered by UN financial institutions involving foreign exchange will require the approval of the Department of Economic Affairs, GoI. • India will allow UN agencies and international NGOs already operating in the country at the time of the disaster event to continue their humanitarian assistance to people in the affected area in coordination with the relevant Central Ministries/Departments and the State Government as per applicable norms and protocols.
	<ul style="list-style-type: none"> • Reason of not accepting : <ul style="list-style-type: none"> • Foreign agency may expect something in return • India is self-sufficient and can take care of internal issues
International Efforts	<ul style="list-style-type: none"> • Participation in International Efforts : <ul style="list-style-type: none"> • India plays an active role in global initiatives on disaster management. • India is a signatory to the Sendai Framework for Disaster Risk Reduction and is committed to achieve the priorities and the objectives through systematic and institutional efforts. • With multi-dimensional initiatives and expertise, India is taking a leading role in strengthening regional cooperation among South Asian countries for reducing disasters. • BIMSTEC - 'Environment and Disaster Management' is one of the organisation's priority area of concerns. • BIMSTEC Disaster Management Exercise • SAARC - SAARC Disaster Management Centre at Gandhinagar • IORA - Disaster Risk Management & HADR • BRICS, SCO, QUAD, G20
CDRI	<ul style="list-style-type: none"> • India's HADR Assistance : <ul style="list-style-type: none"> • In keeping with our cultural beliefs of Vasudhaiva Kutumbakam – the whole world is one family, India has been playing an important role in providing HADR in the region and beyond. • Operation Maitri – rescue operations during earthquake in Nepal in 2015 • Assistance to Sri Lanka in 2016 during Cyclone Roanu • Earthquake in Indonesia in 2018 • Operation Sahayata 2019: Cyclone Idai in Mozambique • Flooding in Madagascar in 2020 • Mission Sagar & Vaccine Diplomacy during the COVID 19 pandemic • Operation Dost - 2023 earthquake in Turkiye

- It is a partnership of national governments, UN agencies and programmes, multilateral development banks and financing mechanisms, the private sector, and knowledge institutions that aims to **promote the resilience of new and existing infrastructure systems to climate and disaster risks** in support of sustainable development..
- Its objective is to promote research and knowledge sharing in the fields of infrastructure risk management, standards, financing, and recovery mechanisms.
- It was **launched by India** at the **2019 UN Climate Action Summit** in New York.
- It is the Government of India's second major global initiative after the International Solar Alliance, and it **demonstrates India's leadership** in climate change and disaster resilience issues.
- It is in alignment with the Sustainable Development Goals, the **Paris Agreement** on Climate Change, and the **Sendai Framework**.
- Membership in the CDRI is **open to all entities**.
- As of 2023, **39 members**, consisting of 31 national governments and 8 organizations, are CDRI members.

L8 Case Studies

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Odisha Cyclone 1999	<ul style="list-style-type: none">• Deadly cyclone in 1999 : 10K loses loss• Occurred between 29 October – 4 November 1999.• Category 5 storm (wind speed ~260–300 km/h), struck Odisha coast near Paradip.• Caused over 10,000 deaths, Massive destruction in Jagatsinghpur, Kendrapara, Cuttack, Puri• Nearly 15 million people affected; severe damage to infrastructure, agriculture, and housing.• Highlighted the lack of preparedness and disaster response system in India at the time.• IMD didn't predict, No evacuation -> High exposure -> Heavy loss• NGOs and local people provided help <p>15.2 ODISHA SUPER CYCLONE, 1999</p> <p>Odisha is one of the most disaster prone states in India and disasters such as cyclones and floods are constant phenomena in this state. Odisha is divided into 30 districts, 314 blocks, 6799 Gram Panchayats and 50,972 revenue villages (http://odisha.gov.in/content/dist). It has 15,707 square kilometres total area. About 87 per cent of the people live in rural areas and they depend on agriculture for their livelihood. On 29th October, 1999, a severe cyclone struck the coastal districts of Odisha. The life span of the cyclone was around six days. It had a wind speed of 300km/hour, with the tidal waves reaching a height of 7-10 metres which came into inlands 0-15kms and there was incessant rain for 48 hours. It affected about 97 blocks, 12 districts, causing devastation in about 1,200 kilometres. The super cyclone severely affected life and property. About 14,000 villages/wards and 16, 50,086 households were severely affected. More than 15 million people (about one third of state's population) got affected and it took a toll of 9,885 human lives and more than 0.4 million livestock and let another 7,507 persons injured. As per the estimate made by state government, about 7,000 lives were lost due to tidal surge; about 2,000 lives due to cyclonic flood and the rest falling objects and or being blown away due to high speed winds. Out of the human lives lost, 8,119 were from Jagatsinghpur district alone. A total of 3.7 million children were affected and 1,500 were orphaned (UNDMT, 1999).</p> <p>The immediate response of the Odisha Government to the super cyclone was the provision of relief to the affected and prevention of epidemic in the affected area. The government began the urgent task of clearing the roads of debris so that the army, state government and NGOs could deliver relief material by trucks to thousands of affected villages. With corpses and animal carcasses laying all around and water sources being contaminated, the threat of diarrhea, dysentery and malarial fever was quite strong. Several NGOs and the army were engaged in the task of disposing the corpses and animal carcasses. They were also involved in the distribution of relief materials that included food, fresh drinking water and water purifying tablets, clothes and blankets, polythene rolls, medicine and first aid kits. The army also assisted in setting up community kitchens and rural hospitals, where medical personnel were brought in from national and international NGOs.</p> <p>While there were measures taken immediately in the aftermath of the cyclone, there were also some long-term measures taken by the state. On one side, rehabilitation measures were taken to make the community return back to normalcy and on the other side, stringent measures were taken by the Odisha government by way of setting up the institutional structures so that future catastrophes can be handled in an effective manner. One such measure was the constitution of the state disaster management authority.</p> <p>Odisha State Disaster Management Authority (OSDMA)</p> <p>The Government of Odisha constituted the Orissa State Disaster Mitigation Authority under the Societies Registration Act, 1860. OSDMA was a Government owned autonomous body established in 1999, to have a systematic and planned approach to disaster management in the state with the objective of making the people of the state more disaster resilient. OSDMA was the first state level disaster management authority that was established in India. Chief Secretary is the chairman of the OSDMA. Later in 2000, the name of the authority was changed from Orissa State Disaster Mitigation Authority to Orissa State Disaster Management Authority. The major task of OSDMA is to concentrate on disaster preparedness, management and social issues related to disaster management such as capacity building, awareness raising and public education, apart from promoting inter-organisational coordination. During normal time, 90% of its activities go for preparedness and 10% of its activities go for reconstruction. But if any disaster occurs, 90% of its activities go for reconstruction. OSDMA, thus, coordinates various activities of disaster mitigation in the state including capacity building of the community and disaster managers and strengthening of infrastructure, improvement in communication system, etc.</p> <ul style="list-style-type: none">• Odisha became first state to setup Disaster management Authority• 2000 : OSDMA Odisha State Disaster Management Authority established• Focuses on preparedness, mitigation, response, and recovery for all types of disasters.
Bhuj Earthquake 2001	<ul style="list-style-type: none">• Kutch region : falls under zone IV-V -> Prone to earthquake• Still India was not prepared for mitigating the affect• Occurred on 26 January 2001 in Kutch district, Gujarat, at 8:46 AM.• Measured 7.7 on the Richter scale, Epicentre: near Bhuj, Gujarat.• Caused nearly 20,000 deaths, over 1.5 lakh injured, and destruction of 3.5 lakh buildings.• Major cities affected: Bhuj, Bhachau, Anjar, Ahmedabad.• Estimated economic loss: ₹15,000 crore (~\$2 billion).• Exposed poor construction practices and lack of disaster readiness.

15.3 BHUJ EARTHQUAKE, 2001

Gujarat is one of the highly industrialised states in India. As per 2011 census, Gujarat has been divided into 33 districts and the actual population of the state is 60,383,628. Due to its geographic profile, the state is more vulnerable to all kinds of major disasters and it falls under Zone V. Gujarat witnessed a powerful earthquake with a magnitude of 6.9 on Richter Scale at Bhuj (Kutch Region) at 8.46 a.m. on 26th January, 2001. This earthquake was the most devastating in the past 50 years. Its impact was huge in terms of loss of lives and properties. Out of 33 districts, 21 districts got affected by this earthquake and around 16,04 million people suffered terrible loss. It made a large scale devastation in 18 towns, 182 talukas and 7,904 villages in the State. About 20,086 persons were killed and more than 20,717 were seriously injured. Majority people were killed due to the collapse of the buildings. Around 3, 70,000 houses were completely destroyed and over 1.2 million houses suffered extensive damage.

The earthquake spread upto 300km from the epicentre. Kutch district was one of the worst affected districts. The saddest part was around 450 villages were totally devastated and destroyed. Eventually it affected the districts of Rajkot, Jamnagar, Surendranagar, Patan and Ahmedabad. Gandhidham, Morvi, Rajkot and Jamnagar witnessed a major devastation due to its major structures, infrastructures and industrial facilities. Not only industries, but majority of the public buildings also collapsed during the earthquake. These included hospitals, monuments and museums. Bridges, roads and railways also faced minor damages and structural changes. Due to the severity of the earthquake, the entire network of the telecommunications was affected. Power and water supply services also got severely affected.

After the disaster, immediately the Union Cabinet as well as the National Crisis Management Committee (NCMC) under the chairmanship of the Cabinet Secretary held urgent meetings on 26th January itself for relief measures. An Empowered

Group of Ministers (EGoM), under the chairmanship of the Home Minister, was set up and the EGoM along with NCMC started monitoring the situation round-the-clock.

Immediately the restoration of communication services was undertaken on a war-footing and satellite phones, hotlines, HAM radios and mobile phones were pressed into service. The Government of India also provided immediate assistance from the NCCF (National Calamity Contingency Fund) and the PM's Relief Fund. The state government started the rescue and relief operations with the help of armed and Para-military forces. Apart from rescue measures, the state also focused on providing immediate relief to the survivors. Teams of officials were sent to the severely affected areas for a quick assessment of the requirements and for co-ordinating arrangements for ensuring food, shelter and health related supplies. The presence of some well-organised NGOs, which began operating community kitchens, was of considerable assistance. Apart from the central government and the NGOs, the state also received support from the corporate organisations and the international community (Sharma, 2001).

In the aftermath of the severe earthquake, on 8th February, 2001, the state had established the Gujarat State Disaster Management Authority under the Societies Registration Act and the Bombay Public Trust Act. The initial mandate of this institution was to implement and coordinate the recovery, rehabilitation and reconstruction activities in the earthquake affected areas. It also acted as a nodal agency for pre-disaster preparedness and mitigation activities. At the national level, Gujarat was the first state to formulate the state level disaster management policy in September 2002.

- **GSDMA : Gujarat State Disaster Management Authority**
- Emphasis on earthquake-resistant infrastructure, urban planning, and community awareness.
- Turning point in India disaster policy, influence the Disaster Management Act, 2005.

Indian
Ocean
tsunami
2004

- Effected Tamil Nadu
- Occurred on 26 December 2004 after a massive undersea earthquake near Sumatra
- Triggered a series of deadly tsunamis across the Indian Ocean. Magnitude 9.1–9.3
- Worst-affected countries: Indonesia, India, Sri Lanka, Thailand.
- In India, states like Tamil Nadu, Andhra Pradesh, Kerala, and the Andaman & Nicobar Islands were severely hit.
- Over 10,000 people died in India; around 2.3 lakh deaths globally.

15.4 THE INDIAN OCEAN TSUNAMI (TAMIL NADU), 2004

On 26th December, 2004, India experienced the devastating effects of tsunami, caused by a series of earthquakes in the Bay of Bengal, which originated from the West Coast of Northern Sumatra in Indonesia. The magnitude and intensity of the huge and strongest marine earthquake was 9.0 on the Richter scale. First it was recorded around 6.29 AM IST in Indonesia and after three hours it attacked the west of Pule Kunji Great Nicobar, India (7.3 on Richter scale). The earthquake set off giant tsunami tidal waves of 3 to 10 meters high that penetrated inland up to 3 kms (ADB, UN and WB, 2005). The Indian Ocean Tsunami of 2004 had caused devastating damages to the lives and property of many countries and it caused irreparable damages to the Indian coast as well. More than 20 countries experienced major causalities and damages and a total of about 2.2 million people got affected.

The Indian Ocean Tsunami had affected nearly 2,260 kilometres of the coastal areas of India, which covered States namely Tamil Nadu, Kerala, Andhra Pradesh and the Union Territories of Puducherry, and the Andaman and Nicobar Islands. As per the Government of India Report, 12,405 people lost their lives; 6,913 people were injured and 6,47,59 people were displaced from their dwellings. About 100,000 houses were estimated to be damaged or destroyed. Approximately 2,000 kilometers of the Indian coastline was submerged up to a distance of two kilometers.

The Indian Ocean Tsunami had caused huge devastating impact on the 13 coastal districts of Tamil Nadu viz. Chennai, Tiruvalar, Kanchipuram, Villupuram, Cuddalore, Nagapattinam, Tiruvarur, Thanjavur, Pudukottai, Ramanathapuram, Thoothukudi, Tirunelveli and Kanyakumari. Three districts viz. Nagapattinam, Kanyakumari and Cuddalore were the worst affected of all districts, with a death toll of 6,065, 828 and 617 respectively (State Planning Commission, 2005). However, the response to the tsunami was swift and comprehensive and it included a combined effort of government bodies, non-governmental organisations (NGOs), and local community. After the tsunami had struck, it was the local community members who came for immediate rescue, even before the government, NGOs and other players could provide response. Only in the subsequent phase of Tsunami, the Government and NGOs had rendered support. The Government provided relief material and coordinated the relief and rehabilitation programmes. The voluntary organisations and other NGOs were involved in the intervention programmes initiated, in the mitigation, response and recovery activities. In addition to this, even the global communities responded quickly to the tsunami by way of mobilising the resources, required in the disaster response efforts.

The relief measures were undertaken immediately which included search, rescue and evacuation; first aid; shelter; resumption of critical infrastructure; restoring transportation routes; communication lines and electricity; ensuring food and clean water distribution.

After the disaster, the Ministry of Home Affairs, Government of India, was nominated as the nodal agency at the national level for undertaking and co-ordinating relief measures in the affected states and the union territories. It was followed by the establishment of the National Crisis Management Committee (NCMC) in 2005 under the chairmanship of the Cabinet Secretary. The relief efforts were reviewed by the Cabinet Committee of Ministers under the chairmanship of the Prime Minister

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together with secretaries of the relevant ministries/departments and chiefs of the armed forces. From the National Calamity Contingency Fund (NCCF), equivalent of US\$112 million was allocated to the disaster affected states and union territories. The Planning Commission played an important role in the phases of recovery and rehabilitation and the State Governments took the responsibility for implementation of recovery programmes (UN Country Team, 2005).

The Government of Tamil Nadu announced a relief amount of Rs. 4,000/- to each tsunami-affected household, followed by monthly allowance of Rs. 1,000/- per household for three months. Besides, as per the provisions of Government Order, each household was provided 60 kgs of rice, edible oil, 3 litres of kerosene, spices, etc., worth Rs. 2,000/- per household, in addition to germicidal spray three times a day. A relief assistance of Rs. 1,00,000/- was provided for every death caused by the tsunami by the Central Government and Rs. 1,00,000/- by the State Government.

The collapsed structures everywhere had created hindrance in the search, rescue and relief operations. The Public Works Department with the help of local people removed the debris of collapsed buildings, roads, bridges and other structures, as well as uprooted trees, hoardings, etc. The resource persons from Tamil Nadu Agricultural University visited the agricultural lands and cleared the sea water and started the land reclamation process.

Cyclone
Biparjoy

- Formed: 6 June 2023 in the Arabian Sea.
- Made landfall: 15 June 2023 near Jakhau Port, Kutch district, Gujarat, India.

	<ul style="list-style-type: none"> • Categorized as Extremely Severe Cyclonic Storm • Death count = 0, Managed to avoid loss of life • NDMA Alert -> PM Modi -> <ul style="list-style-type: none"> • NCMC -> Cabinet Secretary • NEC -> Home Secretary • Power supply cutoff + backup communication established • Forest officials -> ensure Environment protection
Other Cyclone	<ul style="list-style-type: none"> • Cyclone Phailin (2013) <ul style="list-style-type: none"> • Hit Odisha, October 2013, wind speed ~215 km/h. • Over 1 million evacuated, low casualties (~45) due to good preparedness. • Cyclone Hud Hud (2014) <ul style="list-style-type: none"> • Struck Visakhapatnam, Andhra Pradesh, wind ~200 km/h. • Caused heavy urban damage, 124 deaths, ₹21,000 crore loss. • Cyclone Ockhi (2017) <ul style="list-style-type: none"> • Affected Kerala, Tamil Nadu, and Lakshadweep. • Unpredictable path, over 200 deaths, mainly fishermen.