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Simplify your UPSC Journey

Disaster Management

Syllabus

Disaster Management

- Disaster and disaster management.

Previous Years Questions

2024

- What is disaster resilience? How is it determined? Describe various elements of a resilience framework. Also mention the global targets of Sendai Framework for Disaster Risk Reduction (2015-2030). (Answer in 250 words)
- Flooding in urban areas is an emerging climate-induced disaster. Discuss the causes of this disaster. Mention the features of two such major floods in the last two decades in India. Describe the policies and frameworks in India that aim at tackling such floods. (Answer in 250 words)

2023

- Dam failures are always catastrophic, especially on the downstream side, resulting in a colossal loss of life and property. Analyze the various causes of dam failures. Give two examples of large dam failures.

2022

- Explain the mechanism and occurrence of cloudburst in the context of Indian subcontinent. Discuss two recent examples.

2021

1. 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.
2. Describe the various causes and the effects of landslides. Mention the important components of the National Landslide Risk Management Strategy.

2020

- Discuss the recent measures initiated in disaster management by the Government of India departing from the earlier reactive approach.

2019

- 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.
- 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.

2018

- Describe various measures taken in India for Disaster Risk Reduction (DRR) before and after signing 'Sendai Framework for DRR (2015-30)'. How is this framework different from 'Hyogo Framework for Action, 2005'?

2017

- On December 2004, tsunami brought havoc on fourteen 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 such events.

2016

- 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.
- With reference to National Disaster Management Authority (NDMA) guidelines, discuss the measures to be adopted to mitigate the impact of recent incidents of cloudbursts in many places of Uttarakhand.

2015

- 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.

2014

- 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 Niño and La Niña fallouts in India.

2013

- 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.

Basics/Concepts

1. Concept of Disaster
2. Hazard
3. Vulnerability
4. Risk
5. Disaster Management Cycle
6. Disaster Management Framework in India

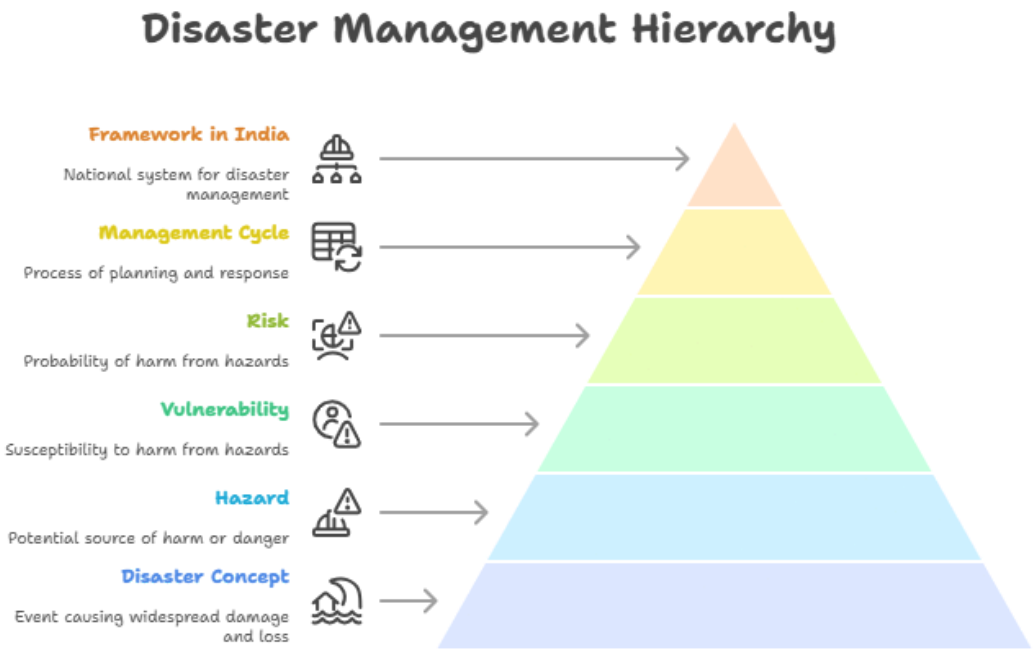
Disaster Management

Disaster

UN International Strategy for Disaster Reduction (UNISDR) offers a commonly accepted definition of a disaster: "A serious disruption of the functioning of a community or a society, involving widespread human, material, economic, or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources."

Classification:

- Tectonic occurrence (earthquakes, volcanoes)
- Meteorological (hurricanes, cyclones, tornadoes, floods, droughts)
- Topographical occurrence (landslides. avalanches)
- Epidemic (locust invasion of crops, epidemics), and
- Human (industrial accidents, nuclear bombs).



Hazard

- A hazard is a dangerous physical condition or event that occurs in proximity.
- Small number of people are affected.
- It may cause injury, loss of life or damage to property.

Classification:

1. **Natural Hazard**: Every year, natural hazards and risks such as earthquakes, cyclones, floods, and drought affect India.the loss of mangroves.
2. **Man Made Hazard**: Explosions; release of hazardous waste; Dam failures; Air, water, and land pollution; terrorism, civil unrest, and war

Hazard Vs Disaster

Hazard	Disaster
Hazard is an event that has potential for causing injury/ loss of life or damage to property/environment.	Disaster is an event that occurs suddenly/unexpectedly in most cases and disrupts the normal course of life in affected area.
Hazards can lead to disasters.	A disaster is the result of a hazard but at the same time is also a hazardous event.
Hazards come with warnings.	Ignoring warnings can lead to disaster.
Hazards may be inevitable.	Disasters can be prevented.
Hazard occurs at less populated area.	Disaster occurs at overpopulated area.

Vulnerability

Vulnerability may be defined as "**conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.**"

Types of vulnerability –

- **Social vulnerability:** This refers to the degree to which individuals and communities are susceptible to harm from disasters due to their social and economic status. Social vulnerability is influenced by factors such as poverty, age, gender, disability, and social inequality.
- **Physical vulnerability:** This type of vulnerability refers to the susceptibility of buildings, infrastructure, and other physical systems to damage or destruction from natural disasters such as earthquakes, floods, and hurricanes.
- **Environmental vulnerability:** This refers to the susceptibility of ecosystems to damage or disruption from natural disasters. Environmental vulnerability is influenced by factors such as climate change, deforestation, and pollution.
- **Economic vulnerability:** This type of vulnerability refers to the susceptibility of individuals, households, and communities to economic harm from disasters. Economic vulnerability is influenced by factors such as poverty, lack of insurance coverage, and dependence on vulnerable industries such as agriculture or tourism.
- **Technological vulnerability**: This type of vulnerability refers to the susceptibility of technology and infrastructure systems to damage or failure during disasters.

India Vulnerability Profile (2nd ARC Report - Crisis Management)

India is very vulnerable to natural hazards because of its unique geo-climatic conditions. Disasters occur in India with grim regularity causing enormous loss of life and property.

- Almost **85% of the country is vulnerable to single or multiple disasters and about 57% of its area lies in high seismic zones.**
- Approximately **40 million hectares of the country's land area is prone to flood, about 8% of the total land mass is vulnerable to cyclone and 68% of the area is susceptible to drought.**
- Some areas are also vulnerable to industrial, chemical and biological disasters.

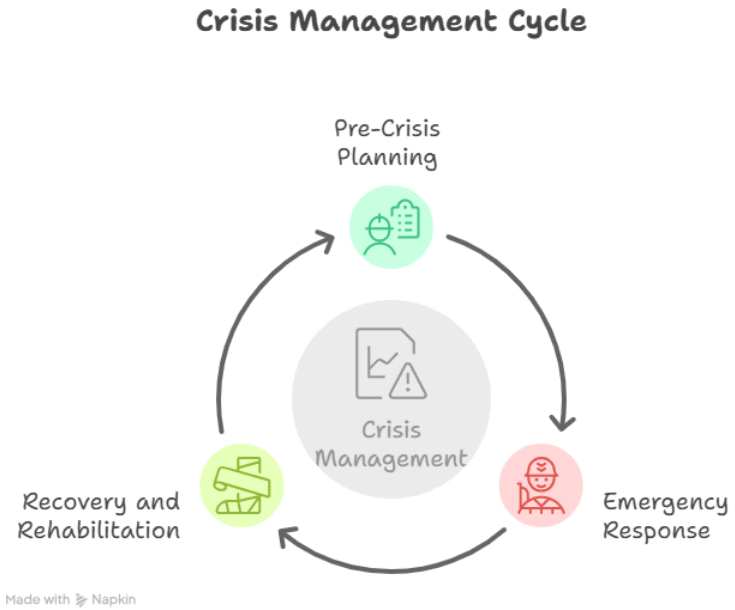
Risk

It refers to **the likelihood or probability of a hazardous event occurring** and the potential negative consequences or impacts it may have on human lives, infrastructure, the environment, and socio-economic systems. It is a combination of the probability of an event happening and the potential severity of its consequences.

Risk = Probability of Hazard x Exposure x Degree of Vulnerability

Disaster Management

Disaster management refers to the **coordinated efforts and actions taken by governments, organizations, communities, and individuals to prepare for, respond to, recover from, and mitigate the impacts of disasters**. The **disaster management cycle**, also known as the disaster risk management cycle or the disaster cycle, **refers to the cyclical process of managing disasters and encompasses the various phases involved in disaster management.**



3-Phases of Crisis Management (2nd ARC - Crisis Management)

Phase 1 - Pre-Crisis: (Preparedness and Risk Management)

1. **Long-term prevention measures** like construction of embankments to prevent flooding, creating or augmenting irrigation facilities and adopting water shed management as drought proofing measures, increasing plantations for reducing the occurrence of landslides, construction of earthquake resistant structures and sound environment management.
2. **Short term measures** which reduce or modify the scale and intensity of the threat, for example, better enforcement of building codes and zoning regulations, proper maintenance of drainage systems, better awareness and public education to reduce the risks of hazards etc.

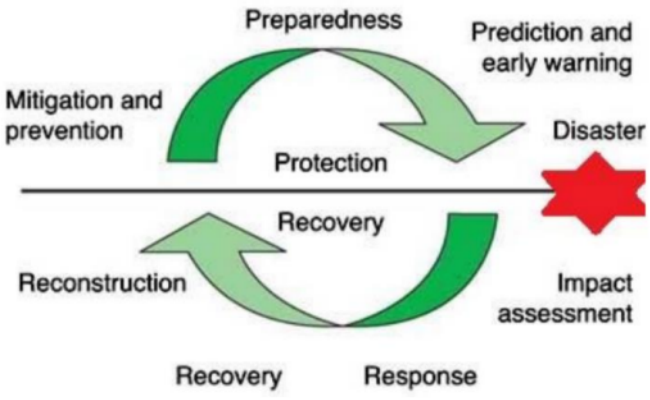
Phase 2 - During Crisis – (Emergency Response)

When a crisis actually occurs, those affected by it require a speedy response to alleviate and minimize suffering and losses. In this phase, certain 'primary activities' become indispensable such as evacuation, search and rescue, followed by provision of basic needs such as food, clothing, shelter, medicines and other necessities essential to bring the life of the affected community back to normalcy.

Phase 3 - Post-Crisis:

(Recovery and Rehabilitation)

1. **Recovery**: In this stage provisions are made to achieve early recovery and reduce future risks. It comprises activities that encompass two



overlapping phases of rehabilitation and reconstruction.

2. **Rehabilitation**: Includes provision of temporary public utilities and housing as interim measures to assist long term recovery.
3. **Reconstruction**: Includes construction of damaged infrastructure and habitats and enabling sustainable livelihoods.

Disaster Management in India

Pre-Independence Era:

- Relief-oriented approach with the establishment of relief departments during emergencies.
- Activities **focused on designing relief codes and implementing food-for-work programs**.
- Relief Commissioners in each state delegated relief material and funds to affected areas.

Post-Independence Period:

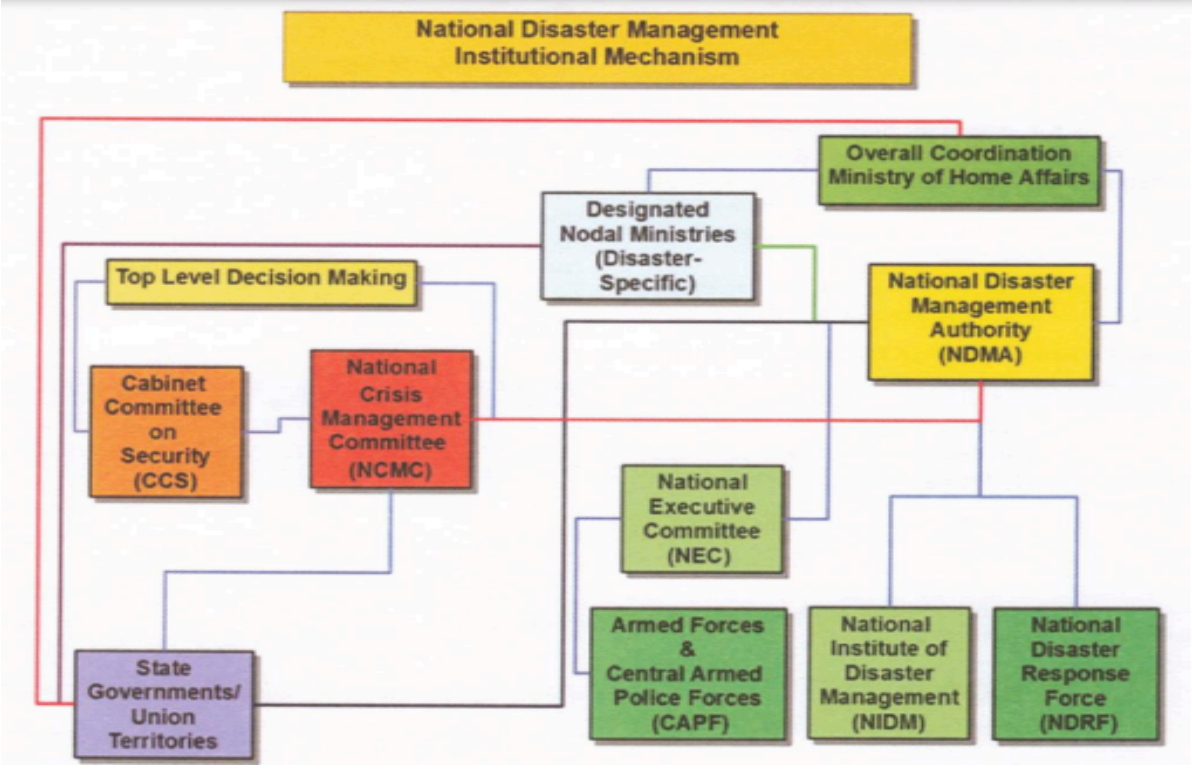
- Continued **reliance on Relief Commissioners for disaster management**. Limited role of Relief Commissioners, primarily involving the distribution of relief materials and funds. Institutionalization and Shift towards Proactive Approach:

1990s:

- Establishment of a **disaster management cell under the Ministry of Agriculture.**
- 1990: UN General Assembly declared the decade as the **'International Decade for Natural Disaster Reduction' (IDNDR).**
- High-powered Committee chaired by **Mr. J.C. Pant** formed after major disasters (Latur Earthquake, Malpa Landslide, Orissa Super Cyclone, Bhuj Earthquake).
- **2002: Disaster management division shifted under the Ministry of Home Affairs.**
- Hierarchical structure for disaster management evolved.

NDMA, 2005

The **National Disaster Management Act, 2005** lays down institutional, legal, financial and coordination mechanisms at the National, State, District and Local levels. The Act provides for the setting up of NDMA at national level, and the SDMA at the state level and the DDMAs at the district level.



NDMA -

It is the **apex body for disaster management, constituted under the DM Act, 2005 and headed by the Prime Minister of India.** It is responsible for laying down the policies, plans, and guidelines for disaster management. The guidelines of NDMA assist the Central Ministries, Departments, and States to formulate their respective Disaster Management (DM) plans.

NDRF -

The **NDRF is a specialist response force that can be deployed in a threatening disaster situation or disaster.** At present, NDRF has a strength of **12 Battalions with each Battalion consisting of 1149 personnel including from ITBP, BSF, CRPF and CISF.**

The "proactive availability" of this Force to the States and its "prepositioning" in threatening disaster situations has immensely helped minimise damage, caused due to calamities in the country.

Funds -

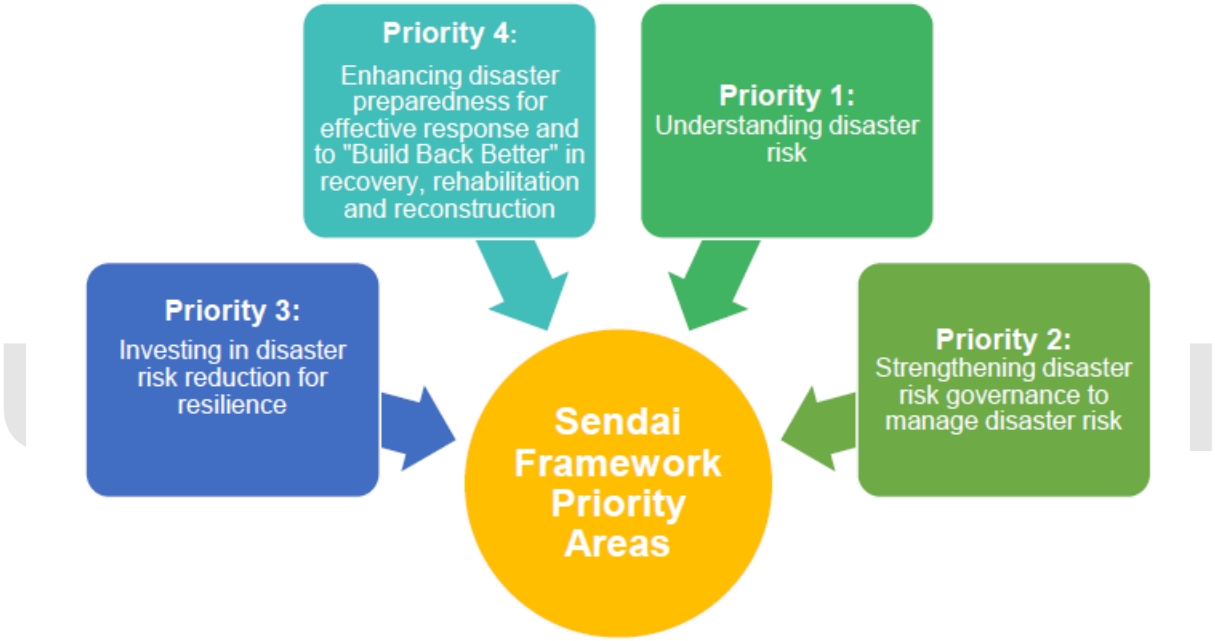
- **National Disaster Response Fund** is a fund managed by the Central Government for meeting the expenses for emergency response, relief and rehabilitation. If the requirement of funds for relief operations is beyond the funds available in the State Disaster Response Fund account, **additional Central assistance is provided from the National Disaster Response Fund**.
- The **National Calamity Contingency Fund (NCCF)** introduced by 11th Finance Commission was merged with NDRF.
- The **State Disaster Response Fund** is used only for meeting the expenditure for providing immediate relief to the victims of disasters

The National Disaster Management Plan, 2016

The Government of India, for the first time, released its first National Disaster Management Plan in 2016. It has been aligned broadly with the goals and priorities set out in the Sendai Framework for Disaster Risk Reduction, the Sustainable Development Goals 2015-2030 and the Paris Agreement on Climate Change at COP-21. It provides a framework and direction to the government agencies for all phases of the disaster management cycle

Sendai Framework for Disaster Reduction 2015-2030

It was adopted at the **Third United Nations World Conference on Disaster Risk Reduction**, held from March 14 to 18, 2015 in Sendai, Miyagi, Japan. It aims to g**uide the multi hazard management of disaster risk in development at all levels as well as within and across all sectors**. It is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters.



The **Sendai Framework sets four specific priorities** for action:

- Understanding disaster risk;
- Strengthening disaster risk governance to manage disaster risk;
- Investing in disaster risk reduction for resilience;
- Enhancing disaster preparedness for effective response, and to "Building Back Better" in recovery, rehabilitation and reconstruction

Earthquake

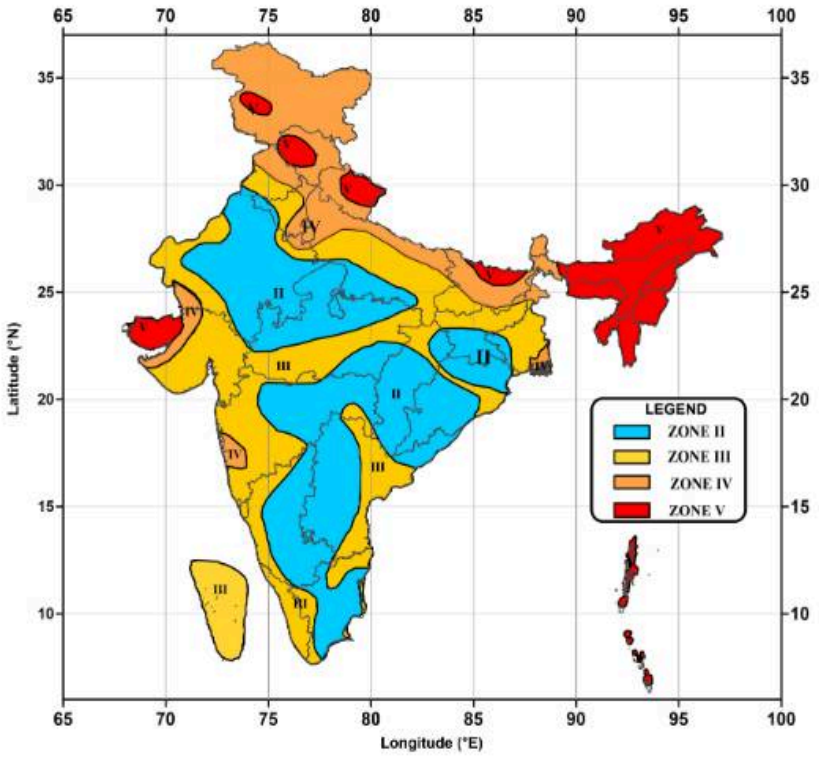
Introduction

According to NDMA, an earthquake is a phenomenon that occurs without warning and involves violent shaking of the ground and everything over it. It results from the release of accumulated stress of the moving lithospheric or crustal plates.

- According to the country's current seismic zone map, moderate to severe seismic hazards threaten more than 59% of India's land area.
- During the last 15 years, the country has experienced 10 major earthquakes that have resulted in over 20,000 deaths.
- Recent earthquakes: Turkey and Syria (2023), North India (Delhi NCR, 2023), Assam (2021)

The **Bureau of Indian Standards** has classified regions in India into **four seismic zones** on the basis of historical seismic activity.

These are **zones II, III, IV and V.** Among these, **Zone V** is the most seismically active region and Zone II is the least active.

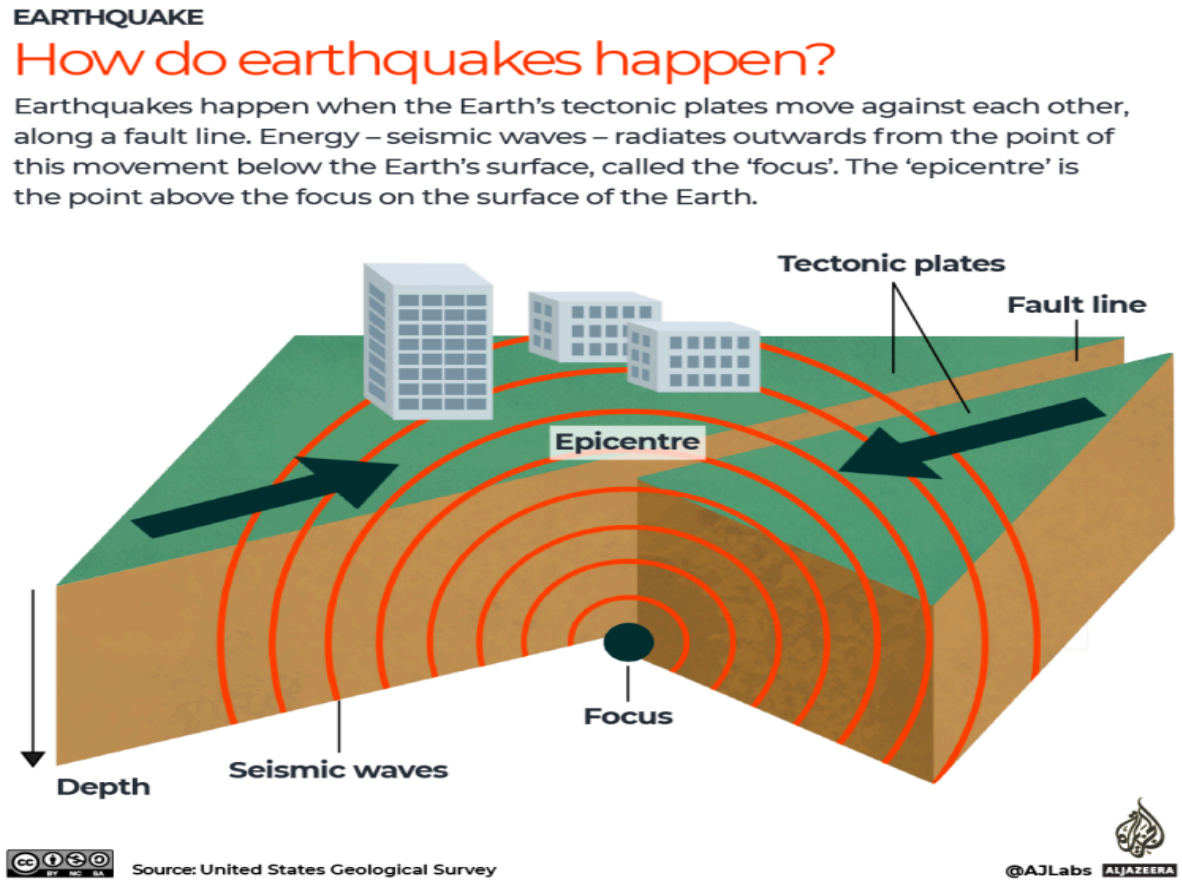


Zone V: Entire North-eastern India, parts of Jammu and Kashmir and Himachal Pradesh, Uttaranchal, Rann-of Kutch in Gujarat, parts of North Bihar and Andaman & Nicobar Islands

Reasons for Earthquakes

Natural Causes

1. **Tectonic Plate Movements**: Plates in earth's lithosphere interact at the boundaries. This non-stop movement causes stress on Earth's crust. When the stresses get too large, it leads to cracks called faults.When tectonic plates move, it also causes movements at the faults. Thus, the slipping of land along the faultline along convergent, divergent and transform boundaries causes earthquakes.
2. **Volcanic Activity**: Earthquakes can occur due to volcanic activity. When magma pushes its way to the surface, it can cause the surrounding rocks to crack and create a volcanic earthquake.
3. **Landslides and Avalanches**: In some cases, a large landslide or avalanche can cause an earthquake. These are usually of relatively low magnitude but can still cause significant local damage.



Anthropological Causes

1. **Mining and Quarrying**: Extractive activities such as mining and quarrying can cause seismic events, known as induced seismicity.
2. **Reservoir-Induced Seismicity**: The added pressure of the water and the infiltration of water into the rock can induce earthquakes.
3. **Geothermal and Oil Extraction**: The extraction of geothermal energy, oil, or gas involves injecting high-pressure fluids into the ground, which can induce seismic activity.
4. **Nuclear Tests**: Underground nuclear tests can cause artificial earthquakes. The explosion creates seismic waves similar to those created by natural earthquakes.

Distribution of Earthquakes

The world's greatest earthquake belt, the **circum-Pacific seismic belt,** is found along the rim of the Pacific Ocean, where about 81 percent of our planet's largest earthquakes occur. It has earned the nickname **"Ring of Fire".** The **Alpide earthquake belt (mid Continental belt)** extends from Java to Sumatra through the Himalayas, the Mediterranean, and out into the Atlantic. This belt accounts for about 17 percent of the world's largest earthquakes, including some of the most destructive. The third prominent belt follows the submerged mid-Atlantic Ridge. The ridge marks where two tectonic plates are spreading apart (a divergent plate boundary). Most of the mid-Atlantic Ridge is deep underwater and far from human development.

Proneness for earthquakes in India

- **Moving Indian Plate:** The Indian plate is pushing into Eurasia at a pace of about 47 mm/year, which is the main cause of the earthquakes' high frequency and intensity.
- **Himalayan belt**: Collision of the Java-Sumatra-Java plate with the Indo-Austral plate, the Eurasian plate, and the Burmese plate. The energy of the underlying rocks is greatly strained by this contact, and some of that energy is released as earthquakes.
- **The Andaman and Nicobar Islands**: It has undersea volcanoes and seafloor displacement that affect the equilibrium of the earth's surface.
- **Deccan Plateau**: The vast majority of areas that can be regarded as safe are found on the stable landmass that the Deccan plateau covers.
- **Other Reasons**: India is becoming more populous and using improper methods to utilise land for construction.

Impact of Earthquakes

The **socio-economic impact** may include -

- Damage of property,
- Loss of life,
- Loss of cattle,
- Fire hazards,

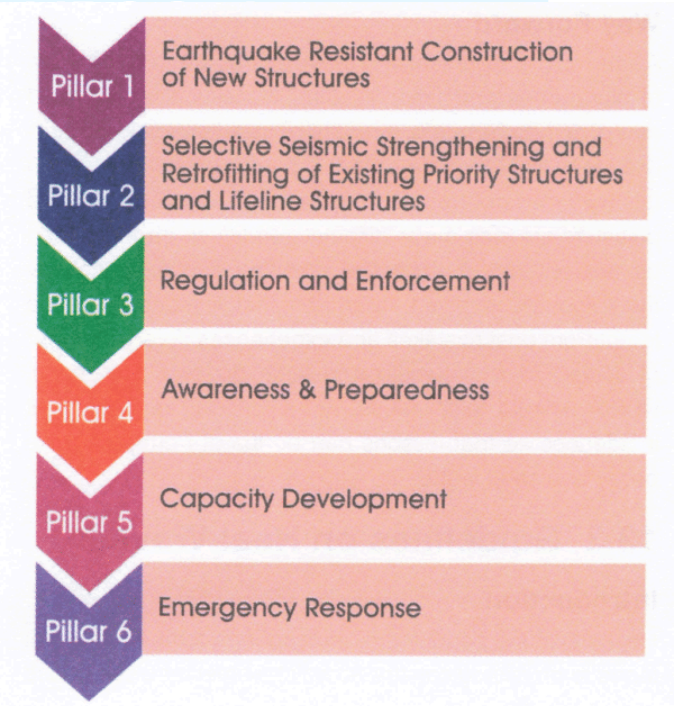
- Breaking of dams,
- Disturbance in economic activities etc.

Physiographic impacts may include -

- Changes in river courses,
- Tsunamis,
- Landslides and avalanches,
- Ground fissures,
- Formation of sinkholes etc

Mitigation and Adaptation (Indian methods)

- **National Building Code (NBC)**: The National Building Code of India 2005 was released for regulating constructions and ensuring earthquake resistant buildings.
- **National Earthquake Risk Mitigation Project:** The proposed project aims to increase efforts to mitigate earthquake damage to both structural and nonstructural assets and lessen vulnerability within earthquake-prone high-risk areas.
- **Building Materials & Technology Promotion Council (BMTPC)**: In order to educate the public and various government agencies about the needs and methods of retrofitting, the BMTPC undertook projects to upgrade lifeline infrastructure.
- Use of technology: Government has launched two apps:
    - **Sagar Vani**: It was designed to help coastal communities, and it provides timely ocean-related information and



alerts to the user community for their safety.

- **India Quake**: Created by the National Centre for Seismology, disseminates real time earthquake information.

- **National Retrofit Program**: The NDMA released guidelines on "seismic retrofitting" along with experts from various IITs and the necessary ministries.
- **The National Centre for Seismology: It is an office under the Earth Sciences Ministry**. It submits reports on earthquake surveillance and hazards to the government.
- The NDMA guidelines cover the basic aspects based on:
  - Earthquake resistant construction
  - Selective seismic strengthening and seismic retrofitting
  - Awareness and preparedness
  - Regulation and enforcement
  - Capacity development by R&D, Training, Documentation etc
  - Emergency response capacity enhancement

Cyclones

According to **NDMA, cyclones are caused by atmospheric disturbances around a low-pressure area distinguished by swift and often destructive air circulation.**

- According to NDMA, India with a long coastline of 8041 kilometres is exposed to nearly 10 percent of the world's tropical cyclones.
- Of these, the majority of them have their initial genesis over the Bay of Bengal and strike the East coast of India.
- Tropical cyclones are intense low-pressure areas confined to the area lying between 30° N and 30° S latitudes, in the atmosphere around which high-velocity winds blow

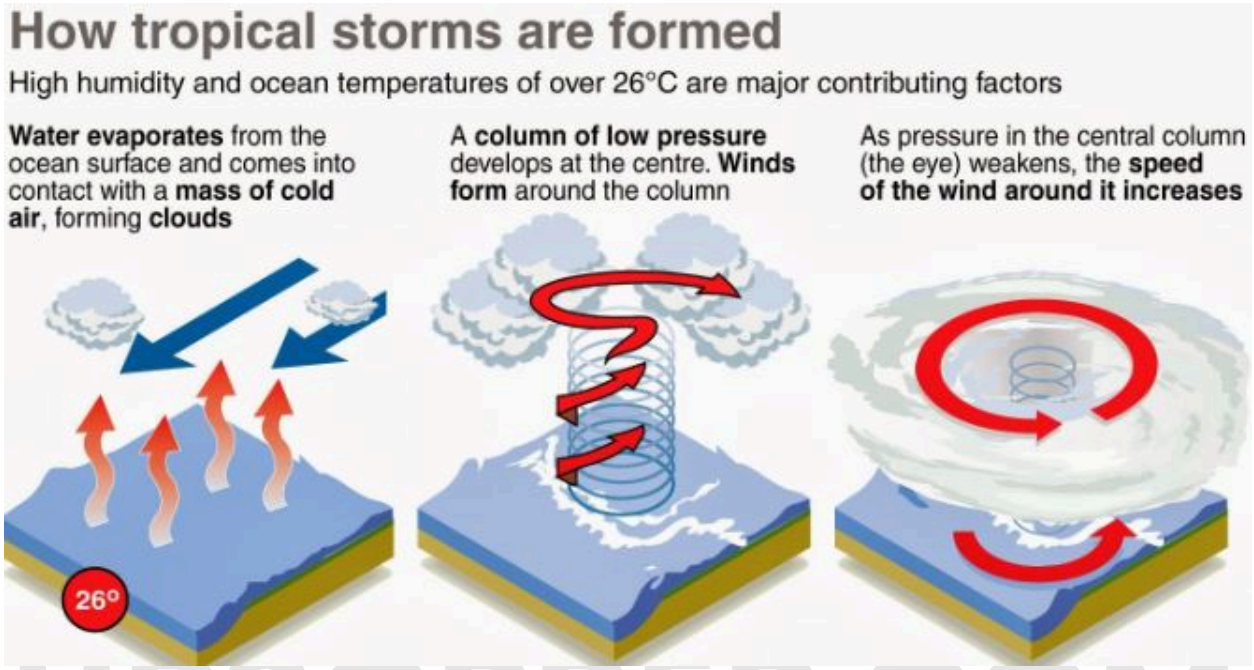
Types of Cyclones

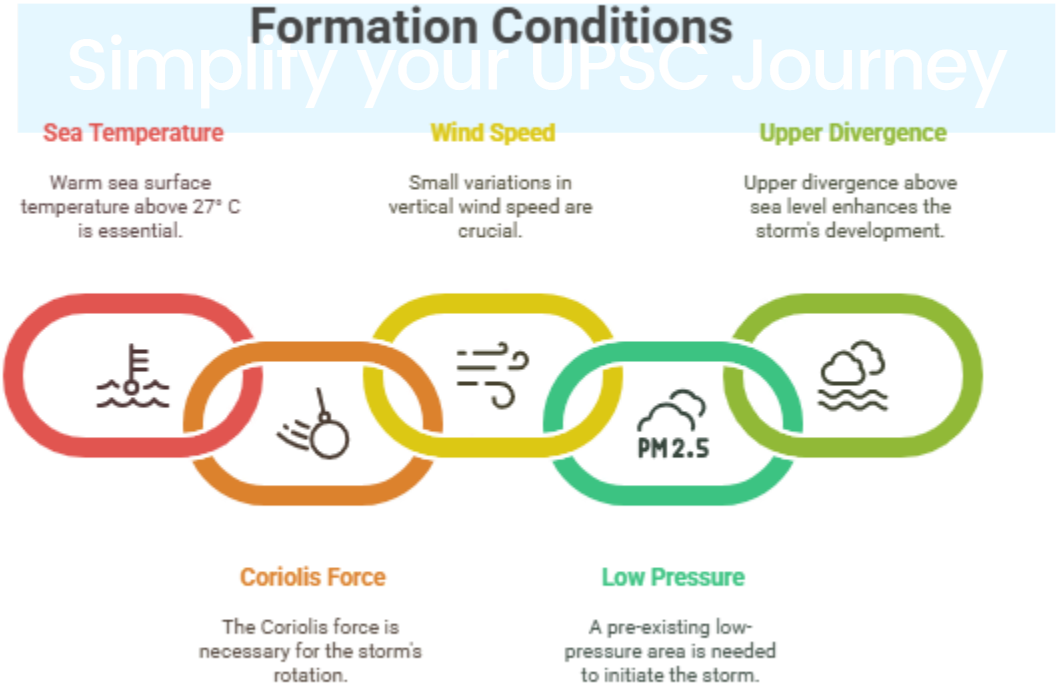
Tropical Cyclone	Temperate Cyclone
Tropical cyclones, move from east to west.	These cyclones move from west to east
A tropical cyclone has an effect on a comparatively smaller area than a Temperate cyclone.	Temperate cyclone affect a much larger area
The velocity of wind in a tropical cyclone is much higher and it is more damaging.	The velocity of air is comparatively lower
Tropical Cyclone forms only on seas with temperature more than 26-27 degree C and dissipate on reaching the land.	Temperate cyclones can be formed on both land and sea
A tropical cyclone doesn't last for more than 7 days	Temperate cyclone can last for a duration of 15 to 20 days

Cyclones are classified as-

1. **Extra tropical cyclones (also called temperate cyclones)**
   Extra tropical cyclones occur in temperate zones and high latitude regions, though they are known to originate in the Polar Regions.
2. **Tropical cyclones.**
   Cyclones that develop in the regions between the Tropics of Capricorn and Cancer are called tropical cyclones. Tropical cyclones are large-scale weather systems developing over tropical or subtropical waters, where they get organised into surface wind circulation.

How Tropical Storms are formed?





Classification

The criteria below has been **formulated by the Indian Meteorological Department (IMD)**, which classifies the low pressure systems in the Bay of Bengal and the Arabian Sea on the basis of capacity to damage, which is adopted by the WMO.

Type of Disturbances	Wind Speed in Km/h	Wind Speed in Knots
Low Pressure	Less than 31	Less than 17
Depression	31-49	17-27
Deep Depression	49-61	27-33
Cyclonic Storm	61-88	33-47
Severe Cyclonic Storm	88-117	47-63
Super Cyclone	More than 221	More than 120

Why are there very few tropical cyclones during the southwest monsoon season?

- The southwest monsoon is **characterised by the presence of strong westerly winds in the lower troposphere (below 5 km) and very strong easterly winds in the upper troposphere**. This **prevents the upward movement of air.**
- Also the potential zone for the development of cyclones shifts to the North Bay of Bengal during the southwest monsoon season.
- During this rainy season, the low-pressure system up to the intensity of depressions form along the monsoon trough, which extends from northwest India to the north Bay of Bengal.
- The depression forming over this area crosses the Orissa-West Bengal coast in a day or two.
- These systems have shorter oceanic stay which is also one of the reasons for their non intensification into intense cyclones.

Why are there fewer cyclones over the Arabian Sea as compared to Bay of Bengal?

- The **Arabian Sea is colder than the Bay of Bengal**, hence the tropical cyclone generated is weak and many fade away before reaching the characteristic level.
- The **Arabian Sea is more enclosed compared to the Bay of Bengal** which is extensively connected to the north pacific.
- For tropical cyclones a wide sea area with warm water is necessary to provide sufficient condensation force. The frequency of typhoons observed in the north pacific shows its influence on the Bay of Bengal and more cyclones are found here.
- Tropical cyclones normally move from east to west. **The Bay of Bengal has a wide area but the Arabian Sea has geographical constraints**.
- However **recently, the Arabian Sea is one of the fastest-warming basins across the global oceans**. One of the reasons for cyclones in the Arabian Sea is because of ocean warming, rapid ocean warming

Impact of Cyclones

- **Human & Economic Toll**: Cyclones result in loss of life, significant property damage, disruption of daily life, and direct economic losses.
- **Food & Livelihood Crisis**: Cyclones often lead to food scarcity due to loss of agricultural supplies. In coastal regions, they hinder fishing activities.
- **Infrastructure & Environmental Damage**: Cyclones can cause severe structural damage, impacting roads, bridges, and revetments, resulting in losses for the public and government.
- **Agricultural Impact & Inequality**: Cyclone-induced crop devastation can reduce farmers' income, increase food prices, and cause unemployment, potentially leading to a rise in crime.
- **Sea Level Rise**: Cyclones can cause an abnormal rise in sea level, known as a storm surge, contributing to coastal erosion and flooding.

Government Initiatives for Cyclone Preparedness

- **National Cyclone Risk Mitigation Project**: India initiated this project to undertake structural and non-structural measures to mitigate the cyclone's effects.
- **Integrated Coastal Zone Management (ICZM) Project**:ICZM aims to improve the livelihood of coastal communities and conserve the coastal ecosystem.
- **Color Coding of Cyclones**: It is a weather warning that is issued by the India Meteorological Department (IMD) to alert people ahead of natural hazards.The four colors used by IMD are Green, Yellow, Orange, and Red.
- **Coastal Regulation Zones (CRZ)**:The coastal areas of seas, bays, creeks, rivers, and backwaters which get influenced by tides up to 500 m from the high tide line (HTL) and the land between the low tide line (LTL) and the high tide line was declared as coastal regulation zone (CRZ) in 1991.

NDMA Guidelines

1. Establishing a **state-of-the-art cyclone EWS** involving observations, predictions, warnings and customised local-scale advice for decision-makers (national/state/district level) for managing the impact of cyclones.
2. Commissioning of **Aircraft Probing of Cyclone (APC) facility for India** with a combination of manned aircraft and **high altitude Unmanned Aerial Vehicles (UAV).**
3. Commissioning of the **National Disaster Communication Infrastructure (NDCI)** at the NDMA/MHA, State Disaster Management Authorities (SDMAs) of coastal states/ UTs and District Disaster Management Authorities (DDMAs)
4. Expanding the **warning dissemination outreach by using the services of Direct-To-Home (DTH) transmission in remote and rural areas (Panchayats)** which cannot be otherwise covered, to introduce weather channel and broadcast cyclone warnings from high-power coastal radio stations including the use of satellite radio service like World Space, Ham radios, community radio and VHF network.
5. Structural safety of **lifeline infrastructure** in coastal areas;

6. Establishing a robust system of locating **multipurpose cyclone shelters** and cattle mounds;
7. Ensuring cyclone resistant design standards are incorporated in the rural/ urban housing schemes in coastal areas;
8. Building **all-weather road** links to all coastal habitations, between habitations and cyclone shelters/cattle mounds;
9. Maintaining the **full designed carrying capacity of main drains and canals along with feeder primary/ secondary/ tertiary channels,** creating additional flood flow canals in frequently inundated areas;
10. Construction of saline embankments to prevent ingress of saline water associated with cyclonic storm surge
11. Encouraging public-private partnership with corporate/trusts.
12. Mapping and delineation of **coastal wetlands, patches of mangroves and shelter belts, identification of potential zones for expanding bio-shield** spread based on remote sensing tools.
13. Regulating infrastructure and development activities in coastal zones.
14. Developing **Integrated Coastal Zone Management (ICZM)** frameworks.
15. Coastal **bio-shields** spread, preservation and restoration/ regeneration plans.
16. **Groundwater development and augmentation of freshwater requirements** in coastal urban centres.
17. Integrate ongoing efforts of the Survey of India, Department of Space under National Spatial Data Infrastructure, National Database for Emergency Management and MoEF.

Cyclone Shelters (special mention in 2nd ARC - Crisis Management Report)

- One of the most successful ways of reducing loss of human lives during cyclones is the provision of cyclone shelters.

- In densely populated coastal areas, where large scale evacuations are not always feasible, public buildings can be used as cyclone shelters.
- These buildings can be so designed, so as to provide a blank façade with a minimum number of apertures in the direction of the prevailing winds.
- The shorter side of the building should face the storm, so as to impart least wind resistance. Earth berms and green belts can be used in front of these buildings to reduce the impact of the storm.

Way Forward

- Planning for land use: Instead of being used for habitation, vulnerable areas should be kept as parks, grazing areas, or flood diversion.
- Shelters: The best locations for cyclone shelter construction should be chosen using a geographic information system.
- Flood Control: A cyclonic storm will result in flooding. Coastal areas will be inundated by storm surges.
- Construction of canals and embankments for improved drainage: Besides improvement to minor drains in the coastal areas a canal network in the coast is an effective tool of water management.
- Shelterbelt plantation: Shelterbelts are barriers of trees that are planted to reduce wind velocities and prevent wind erosion to protect human habitations and agricultural crops.
- Construction of missing road links: It helps in ensuring speedy evacuation of people from vulnerable places to safer areas in the face of an impending disaster threat
- Capacity building : While the hazards due to tropical cyclones cannot be reduced, mitigation strategies to reduce their impacts can be devised.
- Improvement of on-shore warning system: Early reliable warning is one of the important short-term mitigation measures that can reduce the severity of the cyclone-related disasters if acted upon timely.
- Retrofitting of vital installations: Roads/culverts/bridges in the cyclone-prone areas need to be maintained well.
- Awareness generation for cyclone risk mitigation: The public awareness programme with community involvement is an important component of disaster risk management.

Floods

A flood is a natural disaster that occurs when water overflows onto normally dry land. This typically happens when the volume of water within a river or stream exceeds its capacity and spills over its banks, but floods can also result from heavy rainfall, ocean waves coming on shore, rapid snow melting, or dams breaking. According to NDMA, Out of the total geographical area of 329 million hectares (mha), **more than 40 mha is flood prone**.

Cause of Floods

Natural Reasons

- Heavy rainfall: Heavy rain in the catchment area of a river causes water to overflow its banks, which results in the flooding of nearby areas.
- Sediment deposition: River beds become shallow due to sedimentation. The water-carrying capacity of such rivers is reduced. As a result, the heavy rainwater overflows the river banks.
- Cyclone: Cyclone generates sea waves of abnormal height and spreads the water in the adjoining coastal areas.
- Cloud bursts: They result in flash floods, as seen in the Uttarakhand floods in 2013 (Kedarnath Flash Flood) and 2021 (Chamoli Disaster).
- Change in the course of the river.
- Tsunami: Large coastal areas are flooded by rising seawater when a tsunami strikes the coast.

Anthropogenic Reasons

- Interference in a drainage system: Drainage congestion caused by the badly planned construction of bridges, roads, railway tracks, canals etc. hampers the flow of water and the result is flooding.
- Deforestation: As a result of deforestation, the land becomes obstruction free and water flows with greater speed into the rivers and causing floods.
- Floodplain encroachment: Population pressure resulting in encroachments into the floodplains over the years has aggravated the flood problem
- Urban planning: Improper town planning and inadequate drainage arrangement lead to urban floods. Ex: Chennai Floods.

Schemes/Policies/Initiatives

- **Flood Management Programme**: Takes up works related to river management, flood control, anti-erosion.
- **National Water Policy 2012** - emphasizes on large storage reservoirs and other non-structural measures for integrated water management.
- Setting up of **Ganga Flood Control Commission (GFCC)** and **Brahmaputra Board** for advising.
- **Integrated Watershed Management Programme (**IWMP) implemented by the Department of Land Resources of the Ministry of Rural Development.
- Early Warning Systems like **Mumbai's IFLOWS**
- Const. Of **Rashtriya Barh Ayog** (BRA)
- NDMA Guidelines

NDMA Guidelines

Structural -

1. Reservoirs, dams, other water storages

2. Embankments/Flood walls
3. Drainage improvement
4. Dredging of rivers
5. Diversion of flood water
6. Catchment area treatment/afforestation

Non-structural -

1. Flood Plain zoning
2. Flood proofing
3. Flood Management Plans
4. Integrated Water Resources Management
5. Flood Forecasting and Warning in India

Flood Mitigation (2nd ARC)

- Adequate flood-cushion should be provided in water storage projects, wherever feasible, to facilitate better flood management.
- While physical flood protection works like embankments are necessary, increased emphasis should be laid on non-structural measures such as flood forecasting and warning, flood plain zoning and flood proofing.
- There should be strict regulation of settlements and economic activity in the floodplain zones along with flood proofing, to minimise the loss of life and property on account of floods.
- Flood forecasting activities should be modernised, value added and extended to other uncovered areas. Inflow forecasting to reservoirs should be instituted for their effective regulation.

Way Forward

- Modernization in collection of data, forecast formulation and forecast dissemination.

- Integrated food management that works simultaneously for water management, physical planning, land use, agriculture etc.
- Enhanced coordination among agencies.
- Re-mapping the entire flood-prone area.
- Formation of flood management plans at state and local levels.

Urban Floods

Urban flooding is the **inundation of built-up land, especially in densely populated urban areas, brought on by heavy precipitation** (on impermeable surfaces) that exceeds the capacity of drainage systems. The primary cause of flooding is **often inadequate capacity of city drainage systems to handle heavy rainfall**. It can also be exacerbated by the lack of natural drainage pathways, as urban construction typically involves the removal of soil and natural depressions where water can pool.

According to NDMA, it is significantly different from rural flooding as the developed catchments of urban areas increase the flood peaks from 1.8 to 8 times and flood volumes by up to 6 times. Examples - Bengaluru (2022), Hyderabad (2020)

Causes of urban flooding

Direct Factors:

- Climate change induced weather pattern changes and extreme rainfall;
- Topography;
- Unplanned development and encroachment of floodplains; Increment in impervious surfaces;
- Improper drainage infrastructure; etc.

Indirect Factors:

- Improper and inadequate drainage infrastructure due to heavy siltation, poor maintenance, outdated capacity etc.;

- Improper waste management causing waterlogging

Impact of urban flooding

Socio- Economic impact:

- Damage to urban infrastructure and temporary disruption of utility services.
- Economic losses due to disruption in industrial activity and supply chains, damage to vital infrastructure and rebuilding costs.
- Risk of epidemics due to spread of waterborne diseases.
- Casualties due to accidental fires, electrocution.
- Can trigger mass migration or population displacement, especially of people in low lying areas etc.

Environmental:

- Destruction of biodiversity and wildlife habitats by floodwater and contamination of rivers and habitats.

Initiatives to tackle urban flooding

- **Sponge Cities mission** promotes positive interactions between socio-economic systems within the cityscape and with the urban water cycle to enhance local urban resilience.
- **Standard Operating Procedures (SOP)** for mitigating Urban Flooding by the Central Government under the **Atal Mission for Rejuvenation and Urban Transformation (AMRUT)**.
- Flood management programme provides financial assistance to the state governments for undertaking flood management works in critical areas.
- **Uniform System of Alerts and Warnings** by the Ministry of Home Affairs- categorizing alerts in stages – **Yellow, Orange and Red.**
- Integrated Flood Warning system like **IFLOWS-Mumbai.**
- Similar system was also introduced in **Chennai (C-FLOWS).**

Case Study: Success of Davangere and Agartala

- ***Mapping of existing Drainage Systems.***
- ***Removal of Illegal Encroachments over drainage networks.***
- ***Construction of storm water drains to curb water logging and ensure drainage of water after heavy rainfall within few hours***

Urban flooding has become a recurring challenge across many Indian cities due to unplanned urbanization, encroachments on natural drainage channels, and inadequate infrastructure. However, cities like Davangere and Agartala have demonstrated commendable success in managing urban flooding through strategic planning and implementation. Their approaches offer valuable lessons for urban governance and sustainable development.

- **Mapping of Existing Drainage Systems** - Both cities initiated comprehensive GIS based mapping of their existing drainage networks
    a. Natural water channels
    b. Old stormwater drain lines
- **Areas vulnerable to waterlogging**- This mapping helped city authorities identify bottlenecks and overlaps in the drainage system and allowed for scientific planning rather than ad-hoc interventions.
- **Removal of Illegal Encroachments**- One of the critical challenges was the encroachment over natural and artificial drainage channels, which restricted the free flow of rainwater.
- Davangere undertook a massive eviction drive to clear encroachments with public awareness and legal backing.
- Agartala used community participation and compensation-based relocation strategies for effective clearance.

  This restoration of natural drains and water pathways played a major role in improving the city's resilience to rainfall-induced flooding.
- **Construction of Storm Water Drains**- To strengthen the city's infrastructure:
- Well-engineered stormwater drains were constructed or renovated with proper gradient, silt traps, and culverts.

- In Agartala, the construction of box-type RCC stormwater drains was a key intervention, which significantly reduced waterlogging within hours of heavy downpours.
- In Davangere, the design ensured segregation of stormwater from sewage, further enhancing the city's sanitation and resilience.

NDMA Guidelines

1. Early Warning System and Communication -
    - Integration of National Hydro-meteorological network and Doppler Weather Radars.
    - Automated rain gauges for real-time rainfall communication.
    - Flood forecast generation and severity characterization.
    - Implementation of flood management plans.
    - Government-led flood warnings to the public.
2. Design and management of urban drainage (catchment-based design, removal of solid waste to prevent blockages, proper alignment and connectivity of drain inlets)
3. Vulnerability Analysis and Risk Assessment -
    - Identification of high-risk areas
    - Classification of structures and estimation of risk using Hazard Risk Zoning
4. Establish separate urban flooding cells at national level to coordinate activities.
5. Response (emergency operation centres, flood shelters, search and rescue operations, emergency logistics)
6. Sanitation (Adequate sanitation and disinfection to prevent the spread of diseases like dengue, malaria and cholera)
7. Capacity development programmes
8. Participatory urban flood planning and management involving local government and the community

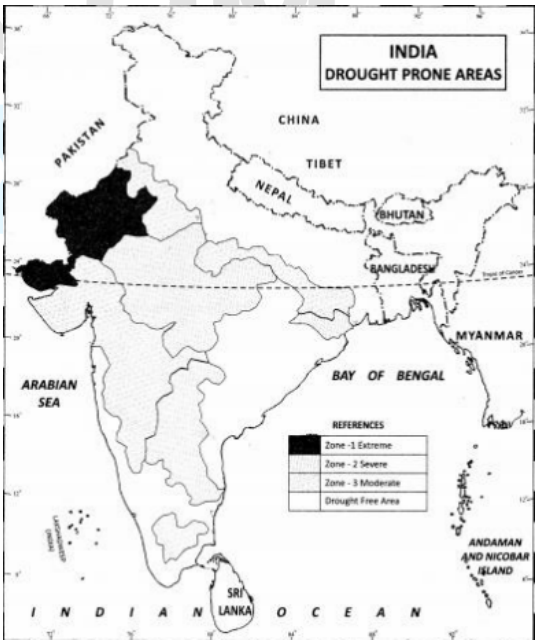
Droughts

India Meteorological Department (IMD) defines drought in any area when the rainfall deficiency in that area is **≥26% of its long-term normal**. According to the Union Agriculture and Cooperation Ministry's Drought Crisis Management Plan document, **68% of the country is prone to drought.**

- According to the **Drought in Numbers Report, 2022**, India is one of the nations that has been most severely hit by the drought.
- The **Global Drought Vulnerability Index** includes India as vulnerable to drought as Sub-Saharan Africa.

2nd ARC on Droughts

- More than 80% of rainfall is received in less than 100 days during the South-west monsoon and the geographic spread is uneven.
- 21% of the area receives less than 700 mm rains annually making such areas the hot spots of drought.
- Per capita water availability in the country is steadily declining.
- The traditional water harvesting systems have been largely abandoned.



Types of Droughts

- **Meteorological Drought**: It is a situation when there is a prolonged period of inadequate rainfall marked with mal-distribution of the same over time and space.
- **Agricultural Drought**: It is also known as soil moisture drought, characterised by low soil moisture that is necessary to support the crops, thereby resulting in crop failures.
- **Hydrological Drought**: It results when the availability of water in different storages and reservoirs like aquifers, lakes, reservoirs, etc. falls below what the precipitation can replenish.
- **Ecological Drought:** When the productivity of a natural ecosystem fails due to shortage of water and as a consequence of ecological distress, damages are induced in the ecosystem.

IMD's classification criteria

The **Indian Meteorological Division (IMD)** has established the following criteria for identifying the drought.

- **Beginning of a drought**: A year's rainfall being more than 25% below average.
- A **moderate drought** is when there is a 26–50% reduction in rainfall from the normal.
- A **severe drought** is defined as a rainfall deficit of more than 50% of the norm.

Vulnerability profile of India

- **Drought prone area**: It has been determined that 30% of the country's total area is susceptible to drought.
- **Affected population**: Approximately 17% of the nation's total land area and 12% of its total population, according to some estimates, experience drought each year.
- **Moderate Drought affected area**: Except for the Konkan most of Maharashtra, Jharkhand, the Coimbatore plateau of Tamil Nadu, the northern portions of Rajasthan, Haryana, the southern districts of Uttar Pradesh, and interior Karnataka.

- **Severe drought affected area**: Eastern Maharashtra, the majority of Madhya Pradesh, portions of eastern Rajasthan, the interiors of Andhra Pradesh and the Karnataka Plateau, portions of northern interior Tamil Nadu, southern portions of Jharkhand etc.
- **Extreme Drought affected areas**: The majority of Rajasthan, especially the regions of Gujarat's Marusthali and Kachchh regions to the west of the Aravali hills.

Effects of drought

- The worst effects include crop failure that causes a shortage of food grains, insufficient rainfall that causes a water shortage, and frequently a shortage of all three.
- **Famine** is often synonymous with the occurrence of drought.
- The most frequent occurrences include the **mass death of cattle and other animals, as well as the movement of people and livestock.**
- Water scarcity forces people to drink tainted water, which leads to the spread of **numerous waterborne illnesses like gastroenteritis, cholera, hepatitis,** etc.
- **Soil degradation** due to long term exposure to heat and loss of moisture. Sometimes it also leads to desertification.
- **Farmer suicides** are also associated with droughts especially in the cotton growing belt of Maharashtra.

NDMA Guidelines for Drought

1. **Creation of Drought Monitoring Cells (DMCs)** at the State level.
2. Implementation of **watershed development plans.**
3. Utilization of **Village Resources Centers** for drought management.
4. Consideration of **cloud seeding policy at national level.**
5. Assessment of Damage and Support measures -
    - Evaluation of agricultural production, water resources depletion, livestock population etc.

- Prompt provision of income credit and consumption loans.
- Development of insurance products for different agro-climatic zones.
- Encouragement of afforestation

6. **Capacity building of officers** and awareness programs.
7. **Support for agriculture during drought** (subsidized availability of short duration variety seeds during late monsoons, promotion of inter-cropping and mulching, creation of fodder banks)

Way Forward

- **Suitable farming methods for arid areas**: Like Production of coarse and hardy cereals; conservation of soil moisture by deep ploughing, storing water behind small dams, collecting water in ponds and tanks and use of sprinklers for irrigation.
- **Sowing drought-resistant crops**: By sowing drought-resistant crops of cotton, Moong, pearl millet, wheat etc, the impact of the drought could be mitigated to a certain extent.
- **Rainwater harvesting** : Collection of each and every drop of rain could help in coping with the drought.
- **Switching to renewable energies**: The alternative is to switch to renewable energy sources, such as wind and solar, which have negligible to no environmental impact and won't cause droughts.

Landslides

According to the Geological Survey of IndiaLandslide is a physical phenomenon when a part of rock, and/or debris/ soil falls due to the action of gravity. It is caused by a set of terrain-specific geo-factors (e.g., slope, lithology, rock structure, land use/ cover, geomorphology etc.) and in general is triggered by heavy rainfall or earthquake tremors. In Indian terrain, landslide events are mostly triggered by monsoonal rainfall but examples of earthquake-triggered landslides are also not uncommon in India (e.g., Uttarkashi Earthquake, Chamoli Earthquake, Sikkim Earthquake etc).

- According to GSI, In India, about 0.42 million sq. km or **12.6% of land area, excluding snow covered area, is prone to landslide hazard.**

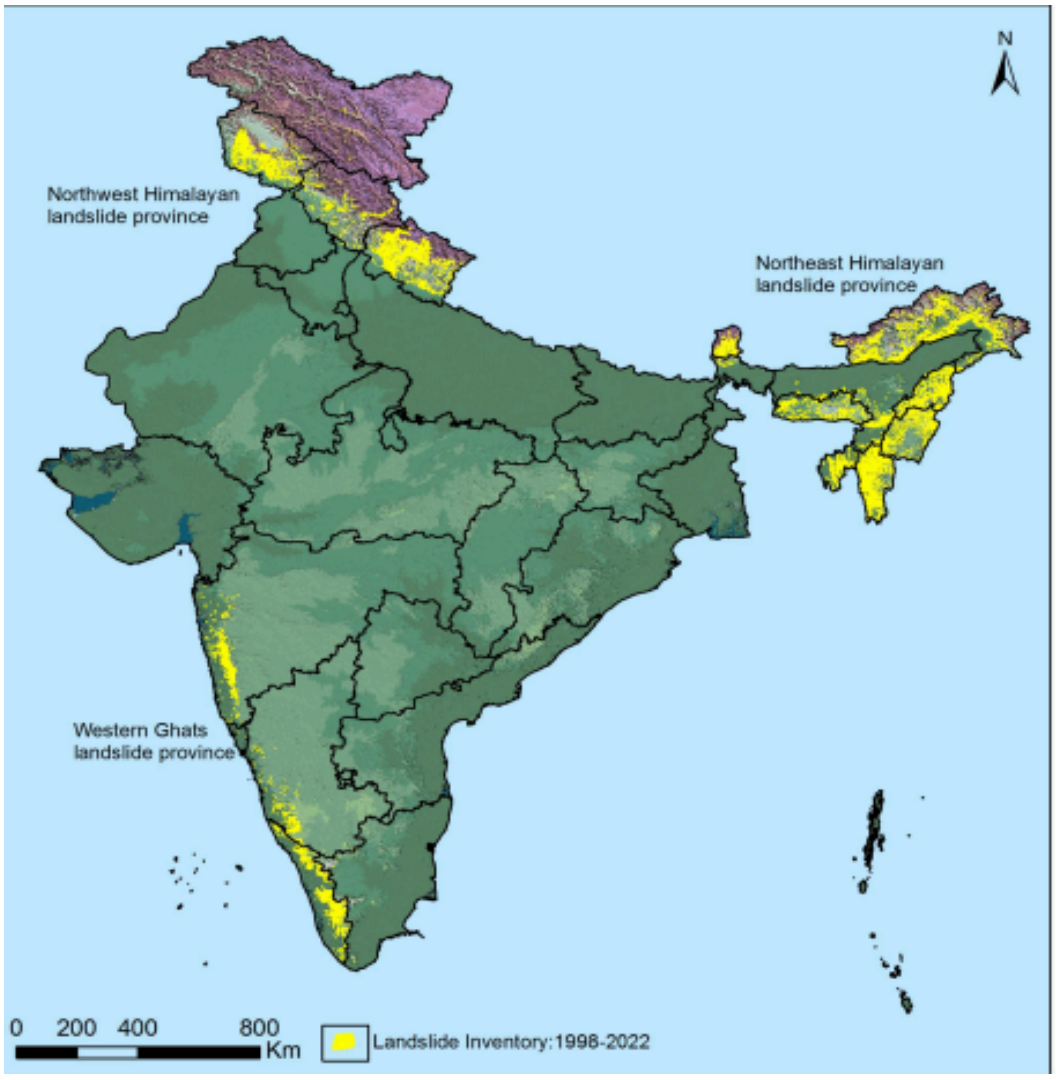


Fig: Landslide Inventory of India

Source: Landslide Atlas (ISRO)

Finding: The North-Western Himalayas are claimed to be responsible for up to 66.5 percent of the landslides, followed by the North-Eastern Himalayas with 18.8 percent and the Western Ghats with 14.7 percent.

Causes of Landslides

- **Heavy rain -** is the main cause of landslides.
- **Deforestation**: Trees, brushes and grasses keep the soil particles compact. Mountain slopes lose their protective cover by felling of trees. The rain water flows on such slopes with unimpeded speed.
- **Earthquakes and volcanic explosions**: Tremors destabilize the mountains and the rocks tumble downwards.
- **Building of roads**: This process dislodges the rock structure and changes the angle of slopes through debris and rocks which consequently landslides are triggered.
- **Shifting agriculture**: In the North Eastern part of India, the number and frequency of landslides has increased due to the practice of shifting agriculture.
- **Construction of houses and other buildings**: In building processes large amounts of debris are created which causes landslides.
- **Urbanisation**: In some parts of India, rising population pressure is concerning. For instance, landslides frequently occur in Dharamshala.
- **Mining**: The forest cover and soil gravel are removed by human activities like mining and quarrying. This reduces the ability of the ground to retain water. Additionally, it raises the chance of floods.

Impacts of Landslides

Short-term impacts -

- Property and life losses.
- Roadblocks and railway line destruction.
- Channel obstruction brought on by rockfalls.
- River stream changes brought on by floods caused by landslides
- Loss of Natural Beauty

Long-term impacts -

- Changes to the landscape that might last forever.

- A reduction in arable land.
- Erosion and soil loss as a result of environmental impact.
- Relocation and population shift of areas and businesses.
- Decreasing water sources

NDMA Guidelines

1. Hazard Zone Identification and Stabilization -
    - Identifying landslide-prone areas.
    - Implementing stabilization measures.
    - Installing monitoring and early warning systems.
2. Area-specific measures -
    - Tailoring mitigation strategies to local conditions.
3. Hazard Mapping -
    - Prioritizing mitigation efforts based on mapping efforts.
4. Restriction on development activities -
    - Controlling construction in high-risk areas.
    - Limiting agriculture and settlements in high vulnerability zones.
5. Afforestation and water flow management -
    - Constructing bunds to reduce water flow and erosion
6. Promotion of terrace farming
7. Construction of retaining walls on vulnerable slopes
8. Landslide insurance and compensation

Mitigation Strategies (2nd ARC)

1. **Micro zonation** so as to regulate settlements in hazard prone areas.

2. **Non-interference with the natural water channels**, construction of retaining walls against steep slopes and strengthening of weak areas with grouting.
3. In India, landslide studies are conducted by a number of institutions, research and academics. However, there is a **need for better coordination among these institutions and also the user agencies.**

Initiatives for Landslides

- Adopt A**valanche Monitoring Radar (AMR)** widely, the first of its kind in India, has been installed in North Sikkim.
    - It has the capability to detect avalanches (mass of snow, rock, etc, that flows down a mountain) within three seconds of its trigger
- Landslide EWS by GIS under **LANDSLI**P Project.
- **GIS's landslide susceptibility mapping** in different parts of India.

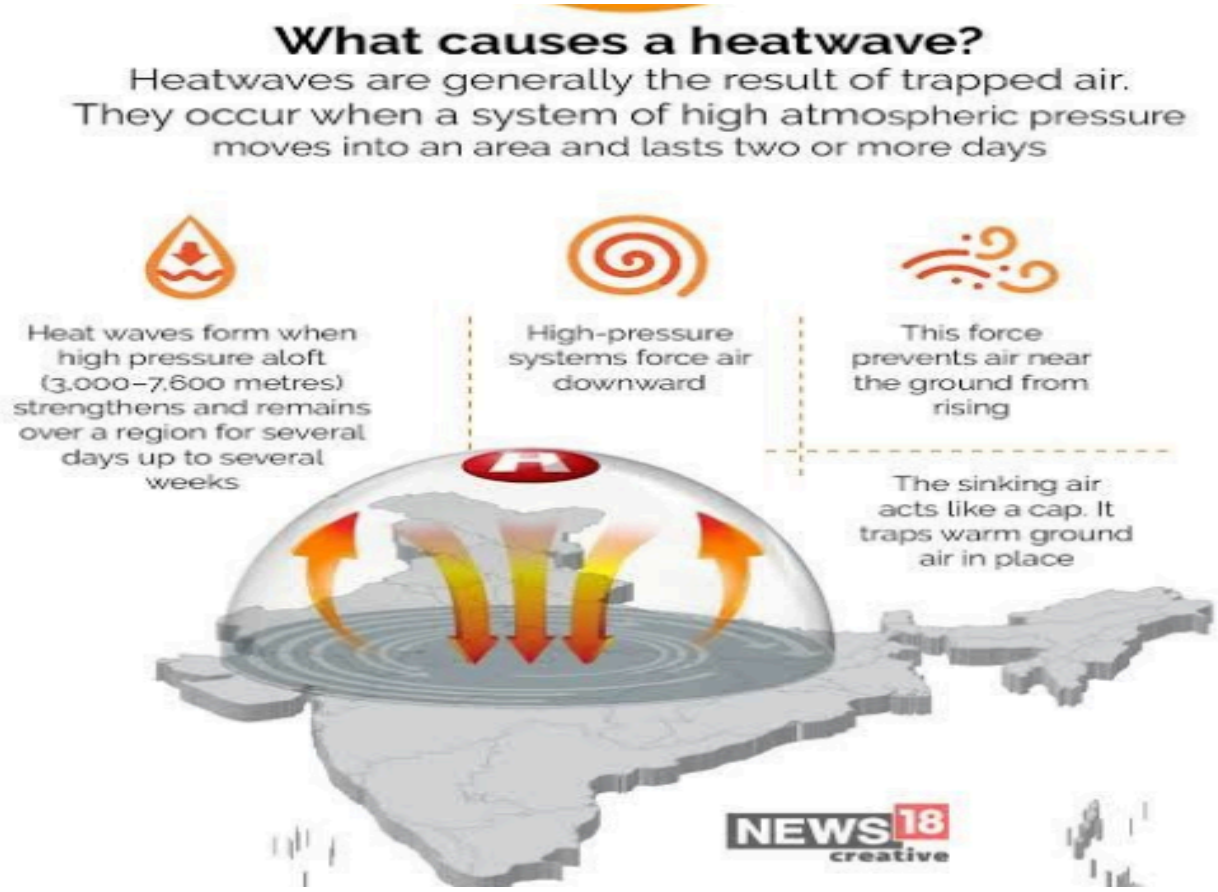
Way Forward

- New technology in road construction: Roads should be constructed in such a way that a lesser amount of debris is generated.
- Banning: Ban on quarrying of stones and mining of minerals • Forest use: Instead of exploitation of forests, they should be used scientifically.
- Crop replacement: Permanent crops like orchards of fruits should replace the seasonal or annual Drops.

Heatwaves

The **World Meteorological Organization defines a heat wave as five or more consecutive days of prolonged heat in which the daily maximum temperature is higher than the average**

maximum temperature by 5 °C. In India it occurs mainly from March to June and in some rare cases even in July. The peak month of the heat wave over India is May. Heat Waves have not been notified as a Disaster as defined under the Disaster Management Act, 2005 by the Government yet.



Heat waves are also **not notified in the list of 12 disasters** eligible for relief under National/ State Disaster Response Fund norms. However, The National Disaster Management Authority (NDMA) released **National Guidelines for Preparation of Action Plan - Prevention and Management of Heat Wave.**

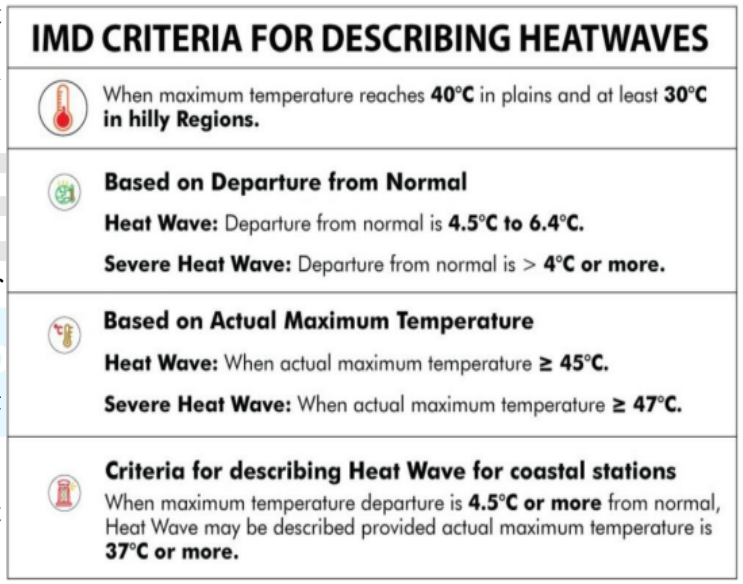
Reasons for intense heat waves in 2022

- Weak western disturbances which bring rainfall and cloudy skies to northwest India and regulate temperatures.

- Anticyclones led to hot, dry weather over parts of western India in March.
- Impact of heatwave was more pronounced in cities due to Urban heat islands (UHI) effect.
- UHI occurs when cities replace the natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat.
- Climate Change has led to extremes of hot weather and heat waves becoming more frequent and more intense.

Impact of heat waves

- **Heat-related illnesses** like Dehydration, heat cramps, heat exhaustion, heat stroke and in serious cases death; etc.
- **Ecosystem damage l**ike accelerated melting of glaciers; impact on biodiversity; deterioration in air quality; drying up of shallow aquatic ecosystems etc.
- Impact on Agriculture like **Drought conditions and decrease in crop yield**; adverse health impact on livestock due to heat stress; etc.



- Economic impact like **Lost wages** due to diminished working hours; **drastic increase in energy demand; food price volatility;** etc.
- **Social impact** like Higher exposure and vulnerability of certain sections like street vendors.

Legislative framework

- India Meteorological Department (IMD) and the National Disaster Management Authority (NDMA) are working with 23 Heat wave prone states identified in 2019 to develop HAPs.
- IMD issues colour code impact-based heat warning jointly with NDMA with suggested actions classified under 4 colors.
- Indian Agricultural Research Institute (IARI) developed an InfoCrop simulation model to forecast heatwave impact on farm yield in real time.
- IMD, in addition to giving out day's maximum and minimum temperatures, will soon issue a HI- a reading that gives estimation of what temperature actually feels like.
- India Cooling Action Plan (ICAP) launched in 2019, aims to provide sustainable cooling measures across various sectors like indoor cooling in buildings, etc.

NDMA Guidelines

1. Mandating participation from state and district government leaders, municipal health agencies, disaster management authorities etc.
2. Designate a State Nodal Agency and Officer responsible for conducting tabletop exercises, simulations, and drills before the heat season, and for coordinating various stakeholders.
3. Vulnerability Assessment and Heat-Health Thresholds.
4. Collaborate with the local IMD office to receive summer season forecast and release early warning and daily alert systems and color codes.
5. Disseminate key messages to communities in advance through information, education and communication efforts.
6. Provide heat wave guidelines in local languages.
7. Assess the efficacy of plan and make necessary updates.
8. Long-term mitigation strategies, such as increasing green cover in cities to reduce the urban heat island effort or implementing cool roofs.

Way Forward

- Retrofitting of infrastructure with cool roof technologies to keep indoor temperatures lower and can help decrease the dependence on air conditioners.
- Increasing the amount of and access to green space and other cool environments (pools, air-conditioned spaces) in urban design.
- Mitigate climate change by reducing greenhouse gas emissions (GHG) and minimize the rise in global mean temperatures.
- Heatwave mitigation in agriculture: Opting for the right crop varieties, bathing animals, and adopting the mulching technique (e.g., Plastic Mulching); Timely sowing and adoption of heat-tolerant wheat crop varieties etc.

WildFire/Forest Fire

In a natural setting, such as a forest, grassland, brush land, or tundra, any uncontrolled and unprescribed combustion or burning of flora that spreads based on environmental factors (e.g., wind, topography). is known as a wildfire. It is also known as a bushfire, vegetation fire, or wildfire.

The study, 'Managing Forest Fires in a Changing Climate', found that there has been a ten-fold increase in forest fires in the past two decades, and that more than 62 per cent of Indian states are prone to high-intensity forest fires. Recently, forest fires have been reported in the Sariska Tiger Reserve in Rajasthan, the Simlipal Wildlife Sanctuary in Odisha, the Ladkui jungles in Madhya Pradesh.

Types of forest fire

1. **Ground Fires:** Ground fires, also known as underground or subsurface fires, occur mostly underground in the organic matter or decomposed leaves in the soil layer. They burn slowly and can be challenging to detect and extinguish because they smolder underground.
2. **Surface Fires**: Surface fires are the most common type of forest fire. They move quickly, burning low-lying plants, shrubs, and other vegetation on the forest floor. Surface fires rarely reach into the tree canopy unless there's a ladder of vegetation (vines, tall shrubs, or low tree branches) that allows the fire to climb.
3. **Crown Fires**: Crown fires, also known as canopy fires, are the most intense and potentially destructive type of forest fire.

Legislative Framework

- Burning or permitting a fire to continue burning in reserved and protected forests is illegal under the **Indian Forest Act of 1927**.
- The **Wildlife (Protection) Act of 1972** makes it additionally illegal to light fires in wildlife sanctuaries.
- To reduce forest fires, the **2018 National Action Plan on Forest Fires (NAPFF)** has been developed. It entails:

- Carrying out fire risk mapping and zoning,
- Involving communities
- Increasing resilience by controlling weeds and biomass. ○ Utilising forest fire alerts based on satellite

- **FPM (Forest Fire Prevention and Management) Program**: It is a centrally funded programme that was started in 2017 and is specifically intended to help the states deal with forest fires.

Causes

Natural Causes of Forest Fire

1. Lightning: This is one of the most common natural causes of forest fires. When lightning strikes, the intense heat can cause trees and vegetation to ignite.
2. Volcanic Eruptions: Lava from volcanic eruptions can ignite forests. The heat from pyroclastic flows and ash deposits can also start fires.
3. Spontaneous Combustion: Under certain conditions, especially during periods of dry and hot weather, organic materials such as dry leaves and twigs can spontaneously ignite, leading to a forest fire.

Human-Induced Causes

(According to WWF International in its 2020 report estimated that humans are responsible for 75% of wildfires worldwide.)

1. **Accidental Ignition**: This can occur due to carelessness, like leaving a campfire unattended, improperly disposing of a cigarette, or failing to fully extinguish a controlled burn.
2. **Arson**: Unfortunately, some forest fires are started intentionally.
3. **Debris Burning**: Burning of debris, garbage, or other materials can sometimes get out of control and lead to forest fires.
4. **Equipment Use and Malfunctions**: Forest fires can be caused by sparks from equipment, power lines, and other machinery.
5. **Fireworks**: Improper use of fireworks can also result in forest fires.

Impact of forest fires

1. **Loss of Biodiversity**: Fires can lead to the death of plant and animal species, reducing biodiversity.
2. **Air Pollution**: Fires produce smoke and release pollutants such as carbon monoxide and particulate matter into the atmosphere.
3. **Soil Degradation**: Fires can deplete nutrients in the soil and increase the risk of soil erosion
4. Damage to property and loss of life.
5. **Health Risks**: Smoke from forest fires can cause health problems, including respiratory issues and other illnesses.
6. **Disruption of Ecological Processes**: Fires can disrupt natural cycles, impacting plant regeneration and wildlife habitats.

Forest fire and mitigation in India

1. **Forest Fire Line**s - Used since British times to prevent fires from spreading.
2. **Pre-Warning Alert System** - Developed by Forest Survey of India, it used parameters like forest type, temperature, rainfall etc.
3. **National Action Plan for Forest Fires (NAPFF)**, was started in 2018 with the goal of reducing forest fires by informing, enabling, and empowering forest fringe communities and incentivizing them to collaborate with state forest departments.
4. **The Forest Fire Prevention and Management Scheme (FPM)** is a government-sponsored programme dedicated to assisting states in dealing with forest fires.

NDMA Guidelines for Forest Fires

- Incorporate Forest Fire Prevention and Management (FFPM) in existing policy and planning documents

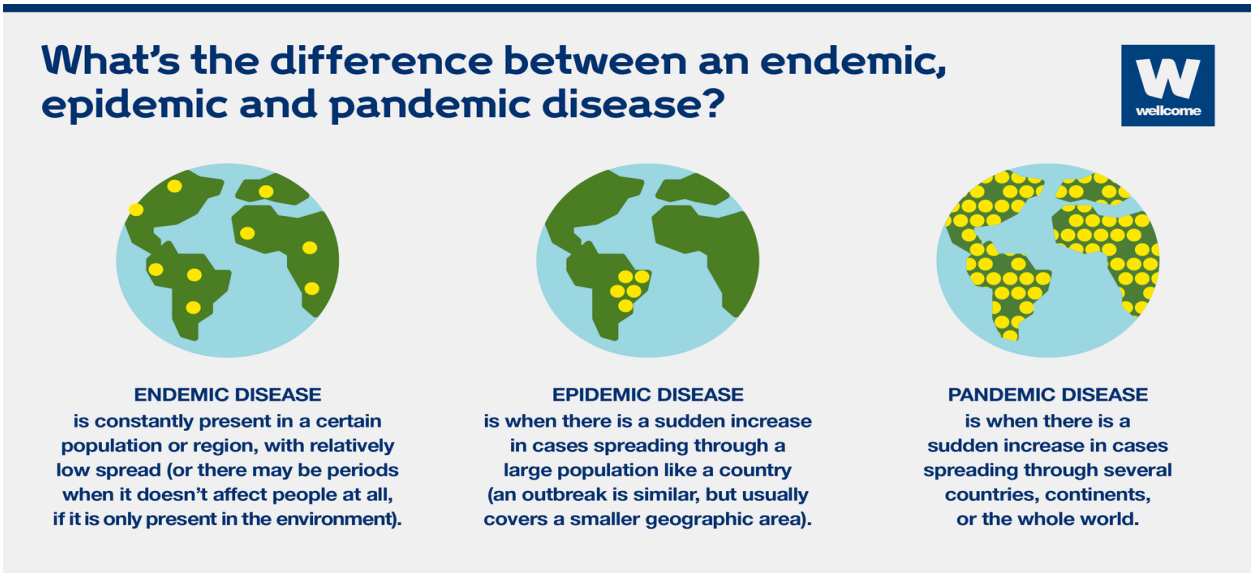
- Establish National Forest fire Knowledge Network.
- Capacity building of forest officials for better use of early warning systems
- Assess risk and prepare vulnerability and risk maps.
- Document national and international good practices and utilise them for making forest fire management more effective and practical
- Increase community awareness.

Recommendations of Council on Energy, Environment and Water (CEEW)

1. **Recognise as a Disaster**: The Forest fires should be treated as "natural disasters" and be brought under the National Disaster Management Authority.
2. **Develop Alert system**: A forest fire-only alert system needs to be developed that can provide real-time impact-based alerts.
3. **Enhance Adaptive Capacity**: Capacity-building initiatives targeted at district administrations and forest-dependent communities can avert the extent of loss and damage due to forest fires.
4. **Provide Clean Air Shelters:** The state government/ state forest departments (SFDs) should repurpose public buildings like government schools and community halls by fitting them with clean air solutions – like air filters – to create clean air shelters for communities worst impacted by fires and smoke from forest fires.

Epidemics

Epidemics refer to the occurrence of a significant increase in the number of cases of a particular infectious disease within a population or geographic area. These outbreaks can range in scale and severity, from localized outbreaks to global pandemics.



Causes of epidemics

- Clearing of Forests: Deforestation can increase contact between humans and disease vectors or animal reservoirs of diseases, leading to spillover events.
- Antimicrobial Resistance (AMR): Overuse or misuse of antibiotics can lead to the evolution of resistant strains of bacteria, causing epidemics of untreatable infections.
- Human Interventions: Changes in land use, construction of dams, irrigation projects, or urbanization can alter local ecosystems and increase the risk of epidemics.
- Exotic Animal Trade: The trade of live animals, especially wild ones, can introduce new pathogens into human populations.
- Migration: Large movements of people, due to conflict, natural disasters, or economic reasons, can spread diseases and strain health resources.
- Climate Change: Changes in climate can impact the range and behavior of disease vectors like mosquitoes, leading to epidemics of diseases like malaria or dengue.

Institutional Mechanisms

The Epidemic Diseases Act, 1897

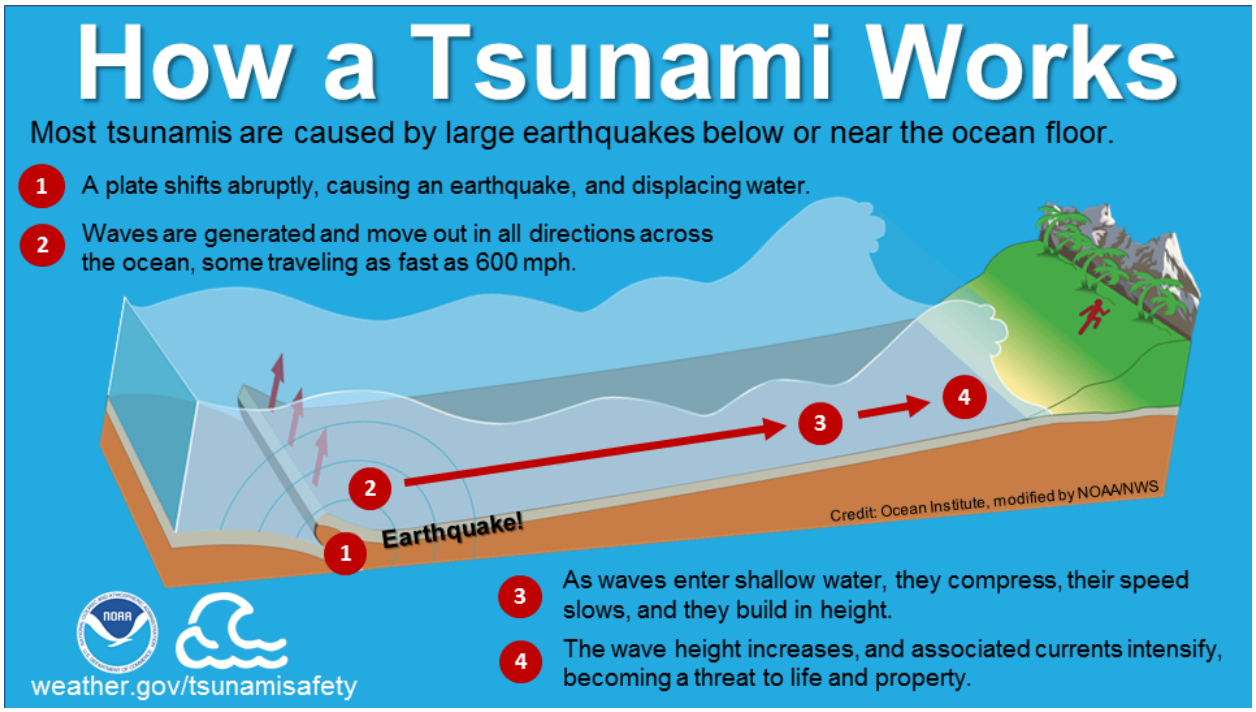
- During a bubonic plague outbreak in Mumbai on January 28, 1897, the Epidemic Diseases Bill was introduced.
- The goal of the Epidemic Diseases Act is to improve prevention of the spread of harmful epidemic diseases.
- In accordance with the Act, temporary rules or regulations can be implemented and made public in order to control or stop disease outbreaks.

Nodal agencies for biological disasters in India

- Ministry of Health and Family Welfare: Responsible for handling epidemics and providing guidance.
- National Institute of Communicable Diseases (NICD): Nodal agency for investigating outbreaks of communicable diseases.
- State Governments: Primarily responsible for managing epidemics at the state level.

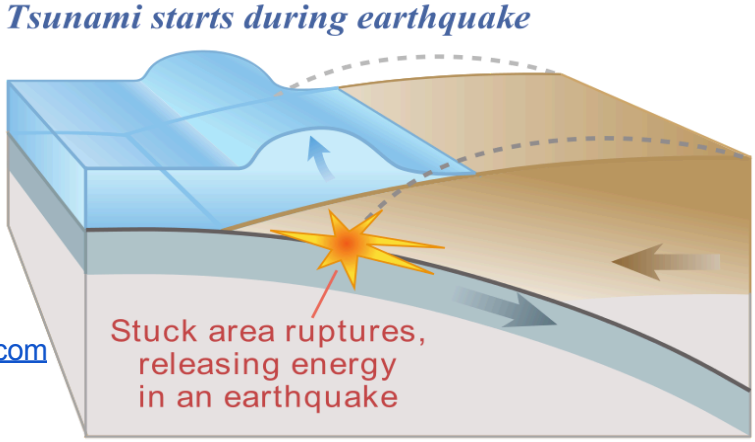
Tsunami

A series of extremely long waves, Tsunami are very long wavelengths of water caused by a large and sudden displacement of the ocean due to earthquakes, volcanic eruptions etc. 2004 Indian Ocean Tsunami: One of the deadliest natural disasters in recorded history, affecting 14 countries and causing over 230,000 deaths. 2011 Japan Tsunami: Triggered by a 9.0 magnitude earthquake, it caused widespread destruction and the Fukushima nuclear disaster.



Characteristics of Tsunami

- The depth of the water affects the wave's speed in the ocean. In comparison to deep ocean waters, it is more vigorous in shallow waters. This causes a tsunami's impact to be **concentrated closer to the coast and less over the ocean.**
- When a tsunami enters shallow water, its wavelength shortens while the period remains constant, increasing the wave height. Over deep water, the tsunami has very long wavelengths (often hundreds of kilometres long).
- Offshore, tsunamis have a small wave height (amplitude). This can be as small as a few centimetres or as tall as over 30 metres. **Most tsunamis, though, have waves that are no higher than 3 metres.**
- It spreads out from the source and covers the entire ocean in all directions.
- It typically **consists of a series of waves**, each lasting anywhere between a few minutes and several hours.



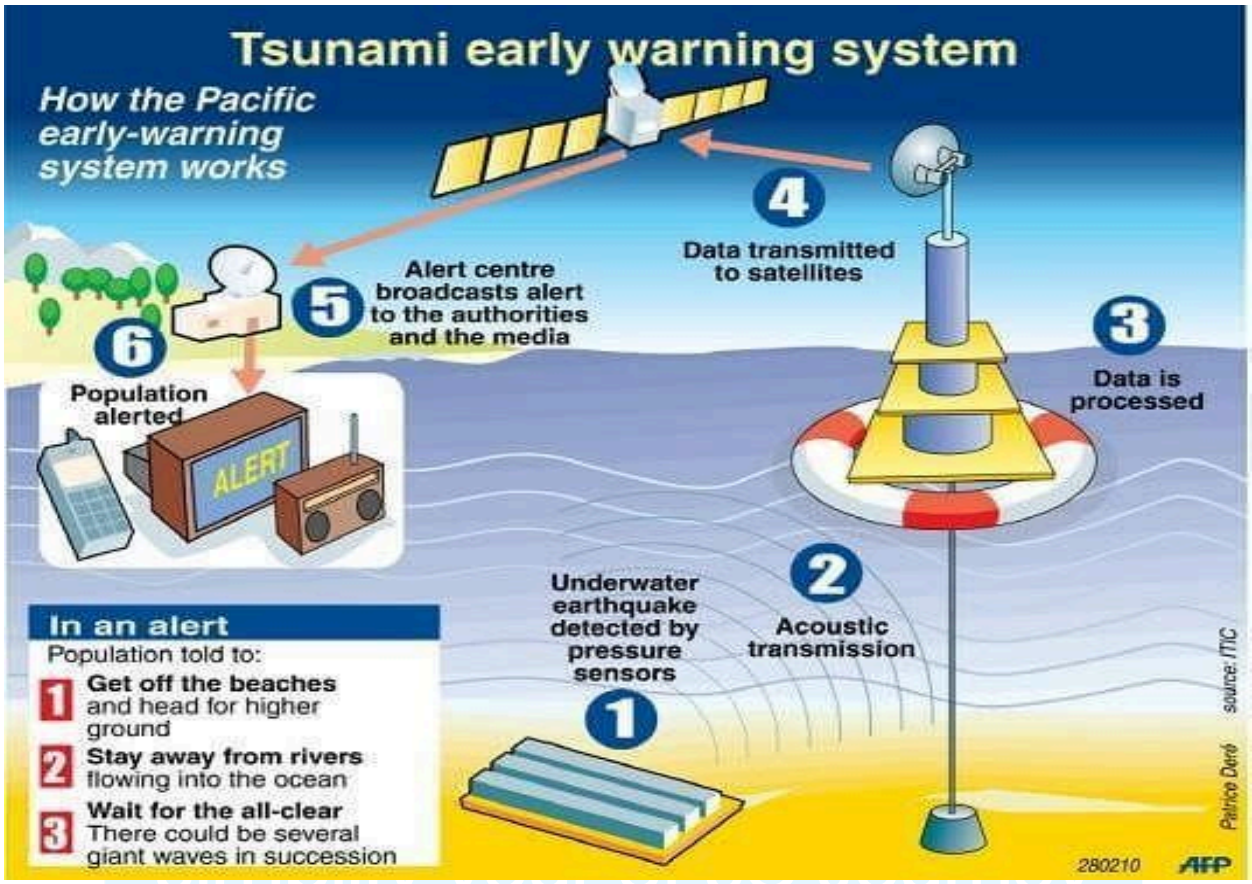
Causes of Tsunami

1. **Earthquake:** When there is an earthquake, the tectonic plates under the ocean slip, creating a classic tsunami wave. Water is forced several metres above the average sea level by the physical shifting of the plates. The horizontal energy is then transferred across the ocean's surface. Waves radiate outward from a single tectonic plate slip, moving away from the earthquake
2. **Underwater explosion**: Nuclear tests conducted by the US in Marshall Island in the 1940s and 1950s caused tsunamis.
3. **Volcanic eruption:** Volcanoes that are located near coastal waters can have a number of effects, some of which can result in a tsunami. Large disposal of lava and explosive eruptions can give rise to tsunami waves.
4. **Landslides**: Landslides are typically caused by earthquakes and volcanic eruptions; when these landslides enter the ocean, bays, or lakes, they can cause tsunamis.

Impact of Tsunamis

- **Loss of Life**: Tsunamis can cause massive loss of life due to flooding and destruction.
- **Infrastructure Damage**: Structures such as homes, bridges, roads, and utilities can be severely damaged or destroyed.
- **Economic Impact**: Damage to businesses, tourism, and local economies can be extensive and long-lasting.
- **Environmental Damage**: Coastal ecosystems, including wildlife habitats, can be severely affected.
- **Displacement of People**: Many people can be left homeless and forced to relocate, leading to humanitarian crises.
- **Contamination of Water Supplies**: Saltwater intrusion can contaminate freshwater supplies.
- **Psychological Impact**: Survivors may face mental health issues such as post-traumatic stress disorder (PTSD).

Tsunami Early Warning Systems



- Even if the system has information on the size and location of an underwater earthquake, it cannot reliably detect the occurrence of a tsunami in time.
- Tsunami Early Warning Systems consist of two primary elements -
    - A sensor network that monitors seismic alerts in order to foretell the arrival of a tsunami wave.
    - A means of communication for informing the public and authorities about the warning
- Early Warning System can be international (e.g. Pacific Tsunami Warning Centre (PTWC) covers the Pacific Ocean) or regional (The Indian Tsunami Early Warning Centre (ITEWC) was established in 2007 at Indian National Centre for Ocean Information Sciences, (INCOIS), Hyderabad, under the Ministry of Earth Sciences is the national authority to issue tsunami advisories for India.)

NDMA Guidelines for Tsunami

- Tsunami Preparedness -
    - IMD envisions establishing a 17- station real time seismic monitoring network (RTSMN).
    - Bottom Pressure Recorders (BPRs) are utilized to detect the propagation of tsunami waves in the open ocean.
- Tsunami Risk Assessment and Vulnerability Analysis -
    - Conduct vulnerability and risk mapping.
    - Development of models for better estimation of arrival time and wave run-up.
    - Tsunami bulletins and warning systems.
    - "Tsunami escape" direction sign boards should be installed in coastal areas.
- Emergency Tsunami Response -
    - Search and rescue operations can involve SHGs, NGOs, and community-based organizations.
- Structural Mitigation Strategies -
    - Development of a network of local knowledge centres (rural/urban).
    - Construction of location specific sea walls and coral reefs.
    - Development of break waters along the coast to provide necessary cushion.
    - Development of bio-shield - a narrow strip of land along coastline.
    - Identification of vulnerable structures and appropriate retrofitting for tsunami/cyclone resistance of all such buildings.
    - Identification of Tsunami shelters.
- Regulation and enforcement of techno-legal regime -
    - Strict implementation of coastal zone regulations.
    - Adoption of a model techno-legal framework.
- Awareness generation and training should be conducted for fishermen, coast guard officials, port authorities etc.
- Regular drills should be conducted.

Conclusion

Disaster management is no longer just a reactive approach but a cornerstone of sustainable development and national resilience. As India faces increasing frequency and intensity of disasters—both natural and man-made—there is a pressing need to shift from a relief-centric model to a holistic paradigm encompassing prevention, mitigation, preparedness, response, recovery, and rehabilitation.

Effective disaster risk reduction hinges on community participation, robust early warning systems, climate-resilient infrastructure, and institutional coordination across all levels of governance. Integrating traditional knowledge with modern technology, promoting local-level capacity building, and aligning with frameworks like the Sendai Framework for Disaster Risk Reduction and SDGs can ensure long-term resilience.

Ultimately, a disaster-resilient India can only be built through inclusive planning, proactive governance, and empowered citizens, turning every crisis into an opportunity for transformation and equitable growth.

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