



# CURRENT AFFAIRS PROGRAM

## PRE CUM MAINS 2024

### NOV 2023: BOOKLET-4

## SPECIAL BOOKLET ON DISASTER MANAGEMENT

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## 1. SYLLABUS AND PYQS

### 1) SYLLABUS

- Disaster and disaster management

### 2) PYQS

- i. 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? [2013] [10 marks]
- ii. **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 fallouts in India. [2014, 12.5 marks]
- iii. 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 [2015, 12.5 marks]
- iv. 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 [2016, 12.5 marks]
- v. 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. [2016, 12.5 marks]
- vi. 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 such event. 2017, 15 marks]
- vii. 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**'? (2018, 250 Words, 15 Marks)
- viii. **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 [2019, 10 marks, 150 words]
- ix. **Disaster preparedness** is the first step in any disaster management process. Explain how hazard zonation mapping will help in disaster mitigation in the case of **landslides** [ 2019, 15 marks, 250 words]
- x. Discuss the recent measures initiated in disaster management by the Government of India departing from the earlier reactive approach [2020, 15 marks, 250 words]

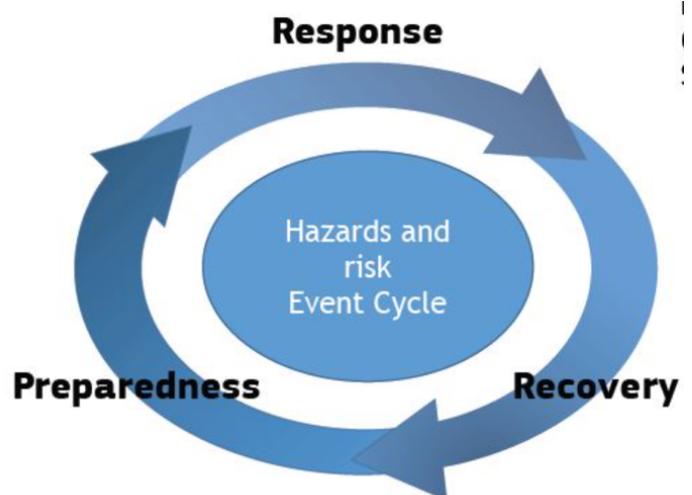
- xi. Discuss about the vulnerability of India to earthquake related hazards. Give examples including the salient features of major disasters caused by earthquakes in different parts of India during the last three decades. (2021, 10 marks, 150 words)
- xii. Describe the various causes and the effects of landslides. Mention the important components of the National Landslide Risk Management Strategy. (2021, 10 marks, 250 words)
- xiii. Explain the mechanism and occurrence of **cloudburst** in the context of the Indian subcontinent. Discuss two recent examples. [2022, 10 marks, 150 words]
- xiv. **Dam Failures** are always catastrophic, especially on the downstream side, resulting in colossal loss of life and property. Analyze the various causes of Dam failures. Give two example of large dam failures. [2023, 10 marks, 150 words]

## 2. BASICS

- "Disaster" is defined under section 2(d) of the Disaster Management Act, 2005 as a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, and is of such nature or magnitude as to be beyond the coping capacity of the affected area.
- Disasters, whether natural or man-made, have been part of man's evolution since times immemorial. Many civilizations including the ancient Indus Valley civilization is thought to have declined because of some natural or man-made disasters.

### 1) DISASTER MANAGEMENT

- **Key Components of Disaster Management**
  - » A disaster needs to be examined in terms of its management cycle that would enable us to anticipate the crisis, prevent and mitigate it to the extent possible and deal with the crisis situation as it emerges.
- The life cycle of disaster Management can be divided into **three phases:**
  - i. **Pre-Crisis: Preparedness/ Risk Reduction**
    - This is the period when the potential hazard risk and vulnerabilities can be assessed and steps taken for preventing and mitigating the crisis and preparing for actual occurrence.
    - **It includes:**
      - Creation of legal and institutional framework



- Hazard Mapping and Vulnerability Analysis.
- Adopting risk reduction techniques
- Setting up Early Warning Systems (EWS)
- Infrastructure improvement for risk reduction
  - **Infra improvement can be both long term and short term.**
    - a. **Long term Measures** - Embankments (floods); Augmenting Irrigation facilities, watershed management (drought proofing); afforestation (landslides); earthquake resistant structures and sound environmental practices.
    - b. **Short term measures** may also reduce or modify the scale and intensity of the threat. This may include implementation of building codes; zoning regulations; maintenance of drainage system; improved awareness in public about disaster etc.
- **Capacity building of government institutions and agencies to ensure fast response during disaster.**

### ii. During Crisis: Emergency Response

- Disaster Response aims to provide immediate attention to maintain life, improve health, and to support the morale of the victim population.
  - It includes activities like **warning, search, rescue, evacuation**, followed by **provisions of basic needs** like first aid, medicine, food, clothing, shelter and other necessities essential to bring life of the affected back to a degree of normalcy.

### iii. Post Crisis: The Three Rs (Recovery Rehabilitation and Resettlement)

- Post crisis activities can be summed in 3 R's: Recovery, Rehabilitation and Resettlement
  - a. **Early Recovery:** This is the stage when efforts are made to achieve early recovery and reduce vulnerability and future risks. It comprises activities that encompass **two overlapping phases of rehabilitation and reconstruction.**
  - b. **Rehabilitation** refers to actions taken in the aftermath of a disaster to enable basic services to resume functioning, assist victim's self-help efforts to repair dwellings and community facilities, and to facilitate the revival of economic activities with more sustainable livelihoods.
  - c. **Reconstruction** refers to permanent construction or replacement of severely damaged physical structures, the full restoration of all services and local infrastructure, and the revitalization of the economy (including agriculture). It should include **development of disaster resilient infrastructure** and must be fully integrated into long-term development plans.

## 2) DISASTER VULNERABILITY PROFILE OF INDIA

- India has recorded the **third highest number of natural disasters** (after China and USA) in last 20 years (2000-2019): Report "**Human Cost of Disasters**" by UN Office for Disaster Risk Reduction (UNDRR).
- **Vulnerability Profile of India:** India faces very high vulnerability due to various factors:
  - » **Adverse geo-climatic conditions**

- **The geo tectonic features** of the Himalayan region and adjacent alluvial plains make the region susceptible to earthquakes, landslides, water erosion etc.
  - **58.6 percent of landmass** is prone to earthquake of moderate to high intensity.
  - **Hilly areas** are at risk from landslides and avalanches.
- Of close to 7516 km long coastline, close to 5700 km is prone to cyclones and Tsunamis.
- **Droughts: The Western Parts of the country, including Rajasthan, Gujarat and some parts of Maharashtra** are hit very frequently by drought situation. If Monsoon worsens the situation spreads to other parts of the country as well.

#### » Socio-Economic Factors

- **High levels of poverty and risk to disasters** are inextricably linked and mutually reinforcing.
  - For e.g., poverty forces people to live in disaster prone regions. The quality of infrastructure, houses etc. available to them are poor.
- High **population density** -> easy spread of pandemic; More pressure on infrastructure - Road/Railway accidents etc.
- **Unplanned Urbanization and unscientific development** -> Urban Floods, Building fires etc.
- **Unregulated industrialization** -> River Pollution; Chemical accidents
- **Development within high-risk zones**

#### » Environmental Factors

- » **Increased land-degradation** -> Famines
- » **Water Pollution** and unsustainable ground water extraction -> Drought

#### » **Climate Change** is expected to further increase the frequency and intensity of current extreme weather events and give rise to vulnerabilities with differential spatial and socio economic impacts on communities.

- » Sea-level rise - coastal flooding
- » Melting of glaciers - River overflow and flooding
- » Higher temperature - Heat waves
- » Variation in weather pattern - Floods and Droughts

- Inspite of this, **India** doesn't have a **database at national level** to record these disasters. In 2018, India had announced that as part of its commitment to Sendai framework, the government would launch "a Uniform and credible national-level disaster database with locally obtained and validated data". But, it hasn't happened yet.

#### » Disadvantages of not having a Central Statistical database

- Major constraints for risk assessment and compilation of disaster history in the country.
- Different sources have different figures for casualties and impact - thereby hindering the objective analysis.
- SFDRR sets various targets, which can't be measured unless there is database.

### 3) WORLD CONFERENCE ON DISASTER RISK REDUCTION AND SENDAI FRAMEWORK

- **Introduction:** WCDRR is a series of United Nations conferences focusing on disaster and climate risk management in the context of sustainable development. The conference has been convened three times, with each edition to date having been hosted by Japan, in **Yokohama in 1994**, in Kobe in 2005 and in Sendai in 2015. UNISDR served as the coordinating body for the second and third conference in 2005 and 2015.
- The conference **brought together** government officials and other stake holders such as NGOs, civil society organization, local government and private sector representatives from around the world to discuss the sustainability of development by managing disaster and climate risk.
- **Three Conferences and Outcomes**

Conference	Outcome
First (1994)	Yokohama strategy and Plan of action of a safer world
Second (2005)	Hyogo Framework for Action 2005-2015 : Building the Resilience of Nations and Communities to Disasters
Third (2015)	Sendai Framework for Disaster Risk Reduction 2015-2030

- **Sendai Framework for Disaster Risk Reduction 2015-2030**
  - **Introduction:** It is a **15-year 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.
  - **Aim:** It aims at following outcome: "The substantial reduction of disaster risk and losses in lives, livelihood and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries".
  - **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 "Build Back Better" in recovery, rehabilitation and reconstruction.

## The Seven Global Targets



### 4) HOW IS SENDAI FRAMEWORK DIFFERENT FROM HYOGO FRAMEWORK FOR ACTION?

- **Time Frame:** Hyogo Framework (2005-2015); Sendai Framework (2015-2030)
- **Focus and Scope:** Sendai Framework has wider scope than Hyogo.
  - **Hyogo Framework** focused on reducing disaster losses and tried to minimize the impacts of disaster
  - **Sendai Framework** broadens the scope by emphasizing the importance of understanding disaster risk and addressing it across multiple sectors. It recognizes that disaster risk is not limited to specific hazards but encompasses all types of hazards, both natural and human-induced.
- **Sendai framework** has also put greater emphasis on **Recovery, Rehabilitation and Reconstruction**.
- **Inclusivity and Participation:** The Sendai Framework places a strong emphasis on involvement of all stakeholders, including governments, local communities, civil society organizations, private sector entities, and others. It recognizes that effective disaster reduction requires collaboration, knowledge sharing, and participation from diverse sectors.

### 5) INDIA HAS TAKEN SEVERAL STEPS FOR DISASTER RISK REDUCTION BOTH BEFORE AND AFTER SIGNING THE SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION (2015-2030)

#### A) PRE SENDAI STEPS:

- i. **Disaster Management Act, 2005** was enacted to provide legal framework to disaster risk reduction in India. It established various institutions and elaborated on their roles and responsibilities.
- ii. **National Disaster Management Authority (NDMA)** was established in 2005 as the apex body for disaster management in India. It is responsible for policy formulation, coordination and implementation of DRR measures across the country.

- iii. **National Disaster Response Force (NDRF)** was established in 2006 as a specialized force for disaster response. It consists of personnel trained in various aspects of disaster management and plays crucial role in rescue, relief, and response operations.
- iv. **National Policy on Disaster Management**, 2009: It outlines the framework for disaster management in India and emphasizes on risk assessment, capacity development, and involvement of multiple stakeholders.

## B) POST SENDAI INITIATIVES TAKEN BY INDIA AND THE WAY FORWARD

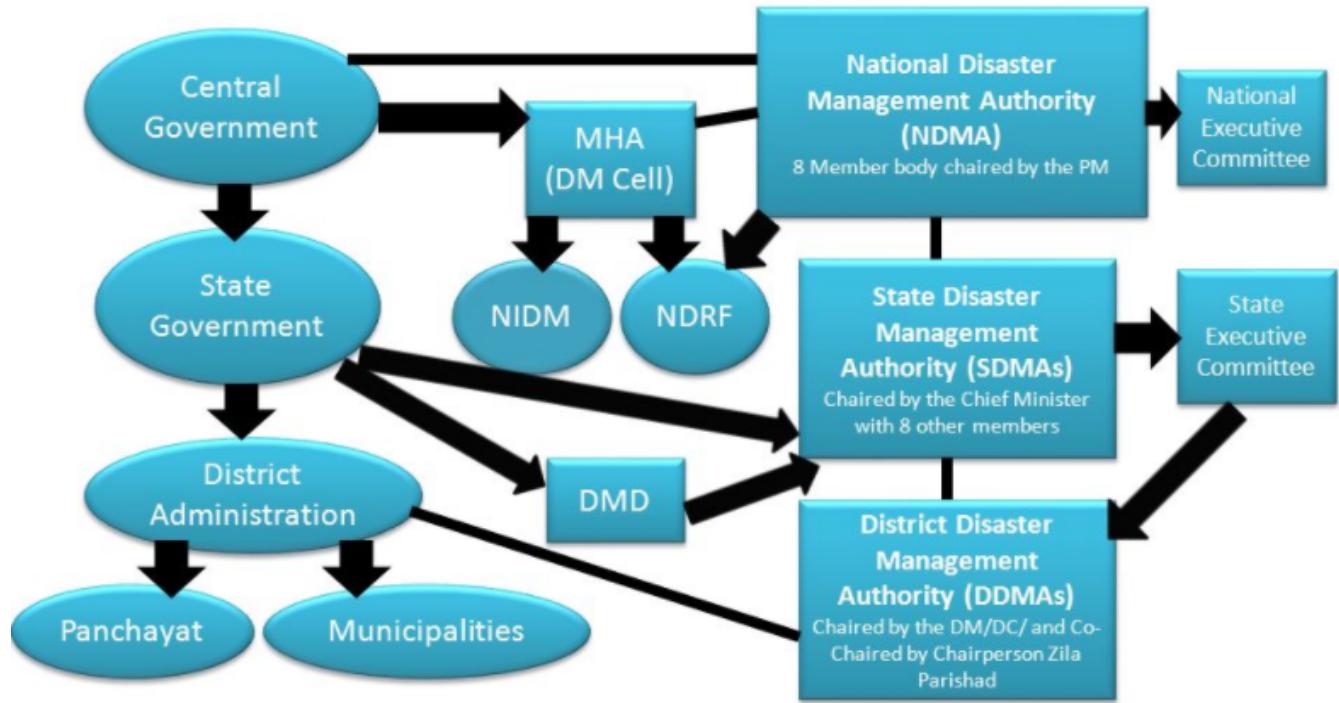
- In furtherance to its commitment to the Sendai framework, Government has taken up several important initiatives post Sendai Declaration.
  - i. India has hosted AMCDRR in Nov 2016 and adopted '**New Delhi Declaration**' and '**Regional Action Plan for implementation of Sendai Framework**'.
  - ii. GoI has issued a set of priority actions to all the state governments based on the goals, targets and priorities of Sendai Framework.
  - iii. **National Disaster Response Force (NDRF) has been strengthened**, both in terms of state of art training and equipment to further empower the professional disaster response force.
  - iv. Government has expressed its keenness to share India's expertise and help other countries in disaster response as it did during the Japan Earthquake in 2011 or the Nepal earthquake in 2015.
    - The government hosts SAARC Disaster Management Centre to reduce disaster risks in the region promoting knowledge sharing among the SAARC countries.
    - Similarly, INCOIS (Indian National Centre for Ocean Information Services) INCOIS, provides early warning not only to India but also to 28 countries in the Indian Ocean Rim.
  - v. NIDM has also signed an MoU with Jawaharlal Nehru University for establishment of a Centre of Excellence in Disaster Research and Resilience Building in JNU for promoting higher education and research within the multi-disciplinary framework.
  - vi. **Disaster Management guidelines** for different kinds of disasters have been prepared
  - vii. India is also in the process of creating National level Database for Disasters in India to help fulfill Sendai Framework requirements.

## 6) INDIA'S INSTITUTIONAL FRAMEWORK FOR DISASTER MANAGEMENT

- **Example Questions**
  - » "Ill-defined and conflicting institutional structures under the disaster management legal framework are among the major obstructions to effective disaster management" Discuss. [10 marks, 150 words]
- **Introduction:**
  - » **Constitution of India** does not mention disaster management under any of the three lists and thus it comes under **the residuary powers of the Union** under entry 97 of the union list. Thus, the power to legislate on the matter is with the Parliament.
  - » After the 2004 Tsunami, the Indian Parliament passed the **Disaster Management Act, 2005** which provides for institutional framework to deal with disasters in India.

- The Disaster Management Act, 2005 has created **new institutions** at the National, state, district and local levels. The new institutional framework is as follows:

## LEGAL – INSTITUTIONAL FRAMEWORK



### i. National Level

1. **National Disaster Management Authority (NDMA)** under chairmanship of the Prime Minister is responsible for policy formulation, making guidelines & best practices, and coordinating with SDMAs to ensure holistic and distributed approach to disaster management.
  - It also has the powers to approve National Plan and Plans of various ministries regarding DM.
  - Powers to superintendence and control of NDRF.
2. **National Executive committee**, chaired by home secretary, is responsible for preparing national plan, assisting NDMA to discharge their functions; monitoring the implementation of the National Policy and ensuring compliance to the direction issued by the Central Government.
3. **National Institute for Disaster Management (NIDM)** (earlier called National Centre for Disaster Management) is responsible for human resource development, planning and promoting training and research in the field of DM. It is also responsible for documentation

and creation of an information base relating to disaster management policies, prevention mechanisms and mitigation measures.

4. **National Disaster Response Force (NDRF)** is a specialized force responsible for quick response to a threatening disaster situation. It can also be deployed to provide assistance to civil authorities in case of impending disasters. It works under the overall supervision of the NDMA.

ii. **State Level**

1. **State Disaster Management Authority (SDMA)**- chaired by CM; responsible for policies and plans of DM at the state level. It also coordinates the implementation of state plan.
2. **State Executive Committee** draws up the state DM plan as prescribed by the national as well as state authorities.
  - It draws up the state disaster management plan as prescribed by the state and National authorities.

iii. **District Level**

1. **District Disaster Management Authority (DDMA)**- chaired by DM and have elected representatives of the local authority as co-chairperson. It is responsible for planning, coordinating and implementing Disaster Management at district level.

iv. **Funding mechanism under DMA, 2005 - Disaster Relief Fund and Disaster Mitigation Fund (at district, state and National Level)**

- See details separately
- **National Policy on Disaster Management, 2009**
- Approved in 2009
  - **Vision:** To build a safe and disaster resilient India by developing a holistic, proactive, multi-disaster oriented and technology driven strategy through a culture of prevention, mitigation, preparedness and response"
  - **Approach:** The policy seeks to evolve a holistic and integrated approach towards DM with emphasis on building strategic partnerships at various levels. The **key themes** of the policy are:
    - i. **Community participation** in the DM
    - ii. **Capacity development** in all spheres
    - iii. **Consolidation of past initiatives**
    - iv. **Cooperation** with agencies at national and international levels
    - v. **Multi-sectoral strategy**
  - The **key objectives** of the policy include
    - i. Ensuring efficient mechanism for identification, assessment and monitoring of disaster risks.
    - ii. Developing forecasting and early warning system.
    - iii. Promoting the culture of prevention, preparedness and resilience among all stakeholders
    - iv. **Encourage mitigation measures** with the help of traditional wisdom, environmental stability and technology.
    - v. Ensuring efficient response and relief with special focus on needs of vulnerable sections.

- vi. **Mainstreaming DM in developmental planning process.**
  - vii. Establishing institutional and technological framework for effective regulatory environment and compliance regime.
  - viii. Making reconstruction and opportunity to build disaster resilient structures and habitat.
- **National Disaster Management Plan, 2016**
- The plan focuses on aligning India's efforts towards Disaster Management to goals and priorities of Sendai framework.
  - **Analysis: Positives of the DMA, 2005**
    - The act rightly emphasizes the need to move from responding to disasters to effective preparedness, which has led to most states investing in resilient infrastructure, early warning systems and evacuation.
      - This has translated into timely warnings, relief shelters and massive evacuation exercises. All these have **reduced causalities**.
    - The **National Disaster Response Fund and State Disaster Response Funds** have helped in guiding immediate relief in the aftermath of disaster.
  - **Some limitations associated with the Disaster Management Act**
    - i. **Too Much Bureaucratization** -> top down approach -> ignores the role of local communities and civil society organizations
    - ii. **Poor Implementation** -> In Swaraj Abhiyan vs Union of India, 2016, the Supreme Court pulled government for poor and slow implementation of the law.
      - For e.g. the NDMF hasn't been created yet.
    - iii. **III-defined and Conflicting institutional structures** under the disaster management legal framework
      - Multiple authorities with overlapping jurisdictions -> lack of clarity in roles.
        - E.g. overlap in powers and functions of central and state governments in defining their ambit and demarcating their roles.
        - E.g. Overlap of role between NEC and already existing National Crisis Management Cell (NCMC).
      - There is absence of transparency and accountability mechanisms under the act.
    - iv. **Need of clarity and transparency on how the political and administrative authorities respond to a tragedy.**
      - For e.g. **multiple nomenclature**.
        - For e.g. in 2018, the Kerala state government didn't know that there is no provision for declaration of the situation as a "national disaster".
        - According to National Disaster Management (NDM) Guidelines, the floods were of "**L3 Level**" severity, i.e. a nearly catastrophic or a very large scale disaster that overwhelms the state and district authority.
        - Disaster Management Division of the Home Ministry declared it a "**Calamity of severe nature**".
    - v. **Neglected NDMA, NEC:** Vacancies, excessive executive incursion by MoHA, lack of regular meeting of NEC (reported in CAG report) etc.

vi. **Funding Misappropriation** (especially from SDRF)

vii. **Lack of Focus on Long Term Recovery**

- The DMA, 2005 largely focuses on improving preparedness, providing immediate relief, and protecting infrastructure. However, it neglects a key aspect of disaster management: Long term recovery.
- Post disaster relief and recovery **have been left to respective ministries and departments**.

- **Key Recommendations of ARC on NDMA, 2005**

i. **Decentralization:**

- **States should play primary role** -> Disaster Management should be the primary responsibility of state governments and union government should only play supportive role.
- **Local government's role should be brought to forefront** in disaster management.

ii. **Ending conflicting institutional structures**

- 2nd ARC recommended the scrapping of NEC as its function coincides with that of the already existing National Crisis Management Committee (NCMC) chaired by Cabinet Secretary.

iii. **Standardize the methodology for assessing a Disaster**

- The act should provide for the categorization of the disaster, this categorization will help in determining the level of authority primarily responsible for dealing with the disaster as well as the scale of response and relief.

iv. **Preventing misuse of the funds**

- The act must provide for stringent punishments and penalties in case of misuse of funds for disaster management

- **Other Important Recommendations**

i. Place Disaster Management in the concurrent list to ensure vertical and horizontal linkages in effective disaster management.

ii. **Long term recovery** needs to be thought of alongside development in an integrated and comprehensive manner by combining with health, skill building, and livelihood diversification schemes.

- **Conclusion**

- There is a need to move towards a regime that exists on a unified, codified and systematic approach to disaster management in which duties of center and states are well defined.

## 7) MANAGING DISASTER RISK REDUCTION FOR SUSTAINABLE DEVELOPMENT

- **Example Questions**

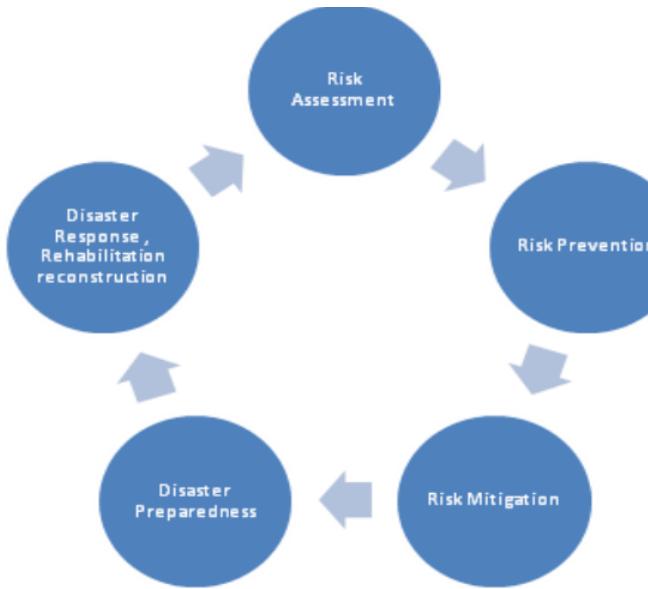
» 'Disaster Risk reduction is the most crucial component of Crisis Management' Discuss [10 marks, 150 words]

- **Introduction**

» Over the years disaster management has evolved from managing events of a disaster to managing the risks of a disaster. In the risk management approach to disaster, various risks of

hazards are analyzed and steps are taken to reduce and control these risks. Here both structural and non-structural steps can be taken for disaster risk reduction.

- » For the residual risk which can't be prevented, there has to be **disaster preparedness** i.e. getting ready to respond to disaster effectively. It involves preparing for early warning, evacuation, search rescue etc. Preparedness further means having policies, strategies and resources in place for 'building back better' livelihoods, houses, infrastructure etc. devastated during the floods.



**Figure 1 From Disaster Management to Disaster Risk Management**

- **Significance of Disaster Risk Reduction**
  - i. Reduces the negative impact of disaster on lives, livelihood and infrastructure.
  - ii. Disaster risk management has assumed critical importance for sustainable development as damage and losses due to disaster are spiraling despite plethora of measures taken to reduce such losses.
  - iii. Economic advantages - WB estimates that India has lost at least 2 percent of our GDP because of disaster.
  - iv. Help in fighting poverty as disaster without risk reduction would undermine hard earned development gains.
    - Disasters generally exposes vulnerable communities and aggravates poverty situation.
- **Disaster Resilient Sustainable Development got a new momentum in 2015** when three parallel yet inter-dependent processes converged to define the development agendas for the next one and a half decade and beyond.
  - » **Sendai Framework on DRR 2015-2030**
  - » **The 2030 Agenda for Sustainable Development** adopted by UNGA in Sep 2015
    - It embedded disaster risk management in as many as 8 out of 17 sustainable development goals.

- » The **Paris Agreement on Climate Change** signed in Dec 2015 outlined 8 specific action areas for enhancing 'understanding, action and support for disaster risk reduction'.
  - These include Early Warning System; Emergency Preparedness; Slow onset events; Events that may involve irreversible and permanent loss and damage; Comprehensive risk assessment and management; Risk insurance facilities; climate risk pooling and other insurance solutions; Non-economic losses; Resilience of communities, livelihoods and ecosystems
- **Steps taken so far**
  - » India has put in place legal and institutional mechanisms at various levels and deployed scientific and technological capabilities for disaster risk management with clearly visible impact on loss of lives, as was demonstrated during some of the recent meteorological disasters like cyclones.
- **Challenges**
  - » **Disaster Preparedness and risk reduction** is invisible as compared to disaster response and **thus is sometimes ignored.**
    - Neither NDMA, nor various ministries and departments have come up with guidelines or concrete plan of action for building disaster resilience in their respective sectors.
  - » **We have not been very successful** in dealing with
    - **Hydrological disasters** like floods or cloudbursts (Uttarakhand, Srinagar, Chennai, Kerala etc) or **geological disasters** like landslides (Malign and north Sikkim)
    - **Technological disasters** like road accidents or industrial accidents continue to spiral;
    - **Threats of biological disasters** like epidemics and pandemics loom large, while **environmental disasters** like depleting water resources and rising level of air pollution in rapidly growing urban settlements are causes of major concerns.
    - India's **ability to manage earthquakes** have not been tested yet since the 2001 Kutch earthquake.
  - » **Our strong scientific base and traditional knowledge and understanding** of the natural and anthropogenic processes of risks of disaster are not being used in process of designing and implementation of social and economic development programmes, activities and projects, with the result that benefit of these projects for disaster risk reduction are not optimized and on the contrary some of these projects are directly or indirectly contributing to creation of new risks of disasters or exacerbation of existing risks of disasters.
- **Way Forward**
  - » **Mainstreaming Disaster Risk Reduction**
    - Implementation of Sendai framework in conjunction with SDG goals, and Paris Climate Agreement provide an opportunities for addressing this hitherto neglected but challenging tasks of disaster risk management in India.
  - » There is a need to **promote awareness generation** regarding adoption of disaster resilient building by laws, land use zoning, resource planning, establishment of early warning systems, and technical competence.
  - » **Promote Knowledge sharing** among Disaster Management community
    - We need a common platform to create a versatile interface among policy-makers in the Government and disaster managers at all administrative levels.
- **Conclusion**

- » If national targets for growth and development - including employment and trade - are to be realized, the shift from managing crisis to managing risk must be reflected in public policy frameworks and planning decision processes so as to enable risk informed investment and practices.

### 3. FLOODS

#### 1) FLOODS – THE MOST RECURRENT DISASTER FOR INDIA

- **Past year Questions**
  - » Why are floods such a recurrent feature in India? Discuss the measures taken by the Government for flood control (1985, 20 marks)
  - » In what way can flood be converted into a sustainable source of irrigation and all-weather inland navigation in India. [2017, 250 words]
- **Other Practice Questions**
  - » "Floods - fluvial or pluvial - are often triggered by extreme weather events, but they translate into disaster risk due to anthropogenic factors" - Elaborate [15 marks, 250 words]
  - » "Floods are natural, but disasters are manmade" Discuss [12.5 marks, 200 word]
- **Introduction**
  - » Inundation of land and human settlements by the rise of water in the channels and its spill-over presents the condition of flooding. Flood is a natural disaster which affects some or the other part of the country for almost every year now. (Kerala, Chennai, Assam, Bihar, UP etc.).
  - » According to ADB, floods are the most devastating among climate related disasters in India. They account for more than 50% of all climate related disasters in the country.
- **Situation in India**
  - » In India, around 40 million hectares area is flood prone, which is 1/8th of the total area.
- **Causes of Floods**
  - » **Natural Causes:** Flood is generally seen as a natural phenomenon. It is associated with:
    - **Heavy Rainfall**
      - Cyclones etc.
      - Monsoon Climate - all rainfall confined to a period
    - **What caused heavy torrential rain in Himachal, Punjab, J&K and Delhi** in the first week of July 2023
      - **Interaction of Western Disturbance with the Monsoon Low Pressure System.**
        - **A western disturbance (WD)** is an extra tropical storm in the upper layers of the atmosphere that is carried towards India by the subtropical jet stream, a band of fast flowing winds that circulates the Earth.
        - **A Low Pressure System (LPS)**, is an area of low pressure that generally forms over seas and oceans and cause rainfall.
        - **This is rare phenomenon** as the WD generally don't occur during Monsoon season. But, global warming have brought variability and have increased the instances of WD during monsoon.

- **A Heat wave in northern Bay of Bengal:**
    - The Bay of Bengal, especially its northwestern part, is usually warm. This enables it to play an important role in NW Monsoon trajectory.
  - **Deep Convection** triggered by orographic uplift combined with the steep terrain of Himalayas.
- **Sediment Deposition**
    - Causes rivers to overflow or change paths
- » **Manmade causes:** Experts believe that the recent increase in intensity of floods have to do a lot with human activities:
  - i. **Climate Change** has led to extreme variability in the intensity of rainfall which has increased the chances of floods.
    - For e.g., global warming has caused rainfall due to western disturbances even in Monsoon season in July 2023 causing huge rainfalls in NW India.
  - ii. **Unplanned development along the natural drainage system** has led to rivers losing its buffer areas and thus any increase in the water levels is causing floods. This include colonization of flood plains and river beds.
    - The number of people living in floodplains across the world increased by 58-86 million during 2000-2015
  - iii. **Indiscriminate Deforestation** has led to increased devastation due to floods. Trees generally acted as a breaker in the intensity of floods.
    - For e.g. According to Madhav Gadgil, if we would have protected Western Ghats, the loss and devastation by the Kerala floods of 2018 would have been less severe.
  - iv. **Unsustainable agri-practices** can also be considered an important factor behind the recent rise in floods.
  - v. **Inefficient Dam Management** sometimes lead to large scale release of water in small time period leading to flood conditions
    - E.g. Kerala floods pf 2018
  - vi. **Urban Floods** are also mostly a result of human made factors
    - **Blocking the natural flow of rivers**
    - **Destroying the natural sinks** like ponds, lakes etc.
    - **Concretization** - Reduces the seepage of water - all water flows and cause floods
    - **Improper Urban Planning** -> siltation of drainage system, Insufficient drainage system
- **Consequence of floods** - Life, Property, Infrastructure, Agriculture, Water Borne diseases etc.
  - » According to Central Water Commission, the total flood related losses in the country were estimated to be over 37 lakh crore from 1953 to 2017.
  - » As per the the State of the Climate in Asia 2021 report, loss and damages from floods, storm cost India **\$7.6 billion in 2021** alone.
- **Some positive impact**

- » It deposits fertile alluvial soil and thus perpetuates the fertility of the area.

- Dealing with Flood Disasters/ Flood Management in India

- a. Risk Reduction, Preparedness

- **Flood Plane Zonation (FPZ)** to mitigate damages caused by floods and to allow rivers their '**Right to Way**'. As a policy flood plain zonation has two major components: Removing Encroachment and Regulating Land Use.

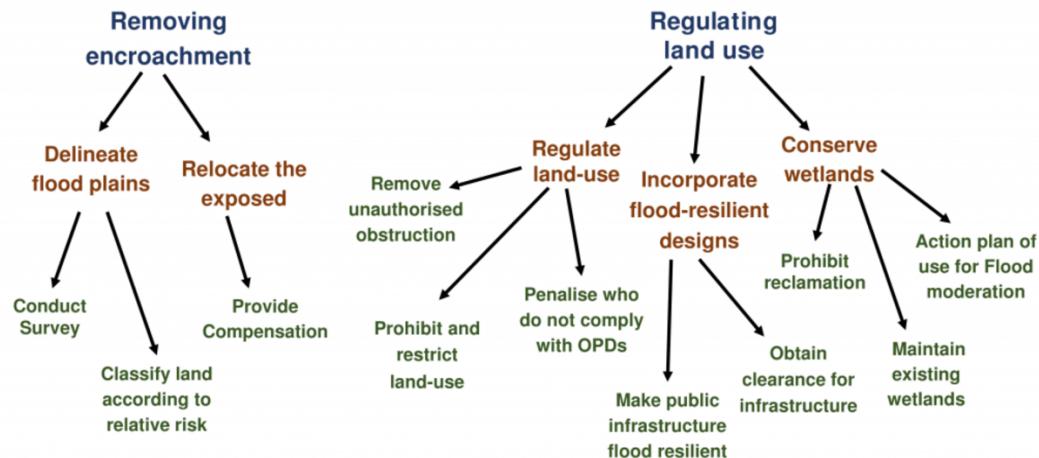


Figure 2: Flow Diagram showing the Operational Attributes of the proposed Floodplain Zoning Policy in India. Source – Modak and Kaduria (2020)

- **Other River Related Steps**

- **Embankments:** e.g. Embankments on Yamuna in Delhi has been successful in controlling the flood to large extent.
    - **Periodic desilting of river**
    - **Watershed based master planning** and development legislated guidelines for **each major river basin** is needed.
      - It should demarcate ecologically sensitive zones.
        - There must be clear land use plan for these zones specifying flood plains, protected forest areas, agricultural and plantation zones.
    - **Continuous modernization of flood forecasting, early warning and decision support systems**
      - There is a need of **more accurate rain forecast** and **more detailed warnings** in place of the current categorization as "heavy" or "very heavy".
      - **IMD** needs more **Doppler weather Radars** which can extend the lead time of forecast by three days.
        - E.g. **IFLOWS-Mumbai** was launched in June 2020 as an state of art integrated flood Early Warning system for Mumbai to enhance the resilience of Mumbai specially during high rainfall events and cyclones.
    - **Reservoirs:** Construction of reservoirs in the course of rivers could store extra water at the time of flood.

- Such measures **have not been much successful**. Moreover it has led to increased deposition of silt in the river and reducing the water flow and further increasing the flood. (e.g. Farakka Barrage causing problems in Bihar)
- Moreover, **during huge floods, dams are double-edged sword**. (e.g. Kerala floods of 2018)
- **Afforestation:** the fury of flood could be minimized by planting trees in catchment areas of the river
- **Planned Scientific Development of Cities**
  - Protect natural sinks like Ponds, lakes etc., development away from the river channel, proper drainage infrastructure, regular cleaning of this infrastructure.
  - Review and revise **building by laws** to focus more on environmental sustainability. They should clearly provide that natural drainage and streams shall not be obstructed by this development/ building permit.
- **Improving awareness and preparedness of all stakeholders** in the flood prone areas.
  - **Regular Drills in Flood Prone Areas** to ensure preparedness of NDRF and awareness among masses regarding steps to be taken during floods.
  - Introducing **capacity development interventions** for effective Flood Management (including education, training, capacity building, R&D, documentation) etc.
- **International Cooperation** with neighboring countries on flood controls as a number of rivers which cause flood in India originate from other neighboring countries.
  - For e.g. Dams on Rivers in Nepal can play an important role in controlling floods in the state of Bihar.

#### b. Response

- Improve the response system of NDRF especially for rural states like Bihar and Odisha.
- Need to enhance capacity building for catastrophic weather events
  - Serious attention needs to be given to fast tracking the setting up of relief camps, crisis proof health infrastructure and stockpiling of dry ration and medicines.
- Increased use of technologies like drones to identify people who are trapped in flood

#### c. Recovery

- Special Focus on Water borne diseases as they are the biggest killer in the post flood situation.
- Ensure that the new infrastructure created is resistant to floods.
- Bring in changes like broadening ecologically sensitive domain to protect more area from environmental degradation.

#### - Conclusion1:

- By recognizing the increasing threat of extreme precipitation and implementing proactive measures, India can improve its resilience to extreme weather events.

- **Conclusion2:**
  - India being a sub-tropical country with Monsoon kind of climate will remain vulnerable to floods due to heavy rainfall and increased climate variability. An efficient disaster management mechanism will ensure that these floods remain a natural phenomenon and doesn't become a natural disaster.

## 2) ASSAM CASE STUDY

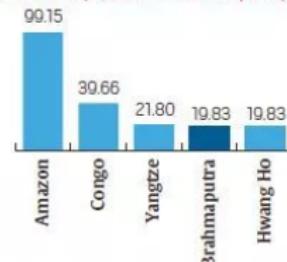
- **Why in news?**
  - Most of the districts of Assam face flood every year. For e.g. in June 2023, more than 11 districts were affected by the first wave of flash floods in Assam (June 2023)
- **Why is Assam so vulnerable to floods?**
  - **Incessant Monsoon Rainfall**
  - **Nature of River Brahmaputra** -> Dynamic and Unstable
    - It figures amongst the world's top five rivers in terms of discharge as well as the sediments that it brings.
    - Because of earthquake prone nature of the region, the river has not been able to acquire a stable character.

### AREA OF INFLUENCE

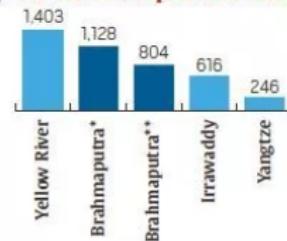


### STRONGEST & SILTIEST

AVERAGE DISCHARGE AT MOUTH (1,000 CUBIC m/sec)



SEDIMENT YIELD (TONNES PER sq km PER YEAR)



\*at Bahadurabad, Bangladesh; \*\*at Pandu, Guwahati

- **Man-Made Factors**
  - Habitation, deforestation, population growth in catchment areas also lead to higher sedimentation in the region.
  - **Destruction of wetlands:** For e.g. Sylhet districts traditional wetlands called 'haor' used to act as sponges absorbing runoff, have been destroyed, thereby enabling the recent floods.
- **How has government tried to address the factors that cause flood in Assam**

- In its master plan on the river in 1982, the **Brahmaputra Board** has suggested that dams and reservoirs be built to mitigate floods .
  - But, the idea has been seen as a double edged sword.
  - Further, opposition from locals, and environmentalists on the grounds of displacement and destruction to ecology, prevented the plan from moving forward.
- **Building Embankments** were proposed as an interim measure to deal with floods and government has recently used this as the only major approach to control floods.
  - But since, there were temporary measures, most embankments which were built in 1980s were not strong enough and thus easily give way in case of overflow of rivers.
- **Dredging** is another thing that government has considered, but experts have opposed it as Brahmaputra sediment yield is amongst highest in the world and next year sediments will reverse the efforts of this dredging. So, even this hasn't been done.

- **Conclusion**

- The above initiatives are clearly not the sustainable solution to floods. There is a need of a **basin wide approach** to the problem. There is a need of integrated basin management system that should ideally bring in all basin-sharing countries on board.

### 3) GLACIAL LAKE OUTBURST FLOOD

- **Why in news?**

- India and Pakistan make up one-third of the total number of people globally exposed to GLOF - around three million people in India and around 2 million people in Pakistan (Feb 2023)
- Scientists suggest that the outburst of a Glacial lake was the primary reason for the Feb 2021 flash flood in the Chamoli district (Feb 2021)
  - The DRDO have said that a portion of the Nanda Devi glacier broke off, creating an avalanche, releasing water trapped behind the ice.

- **Example Questions**

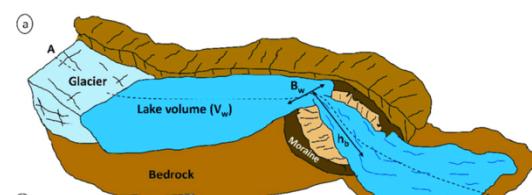
- » Discuss the key factors which is making Himalayan region more vulnerable to Glacial Lake Outburst floods (GLOF). In light of the recent NDMA guidelines, suggest measures to reduce risks of GLOF disasters (15 marks, 250 words)

- **Introduction**

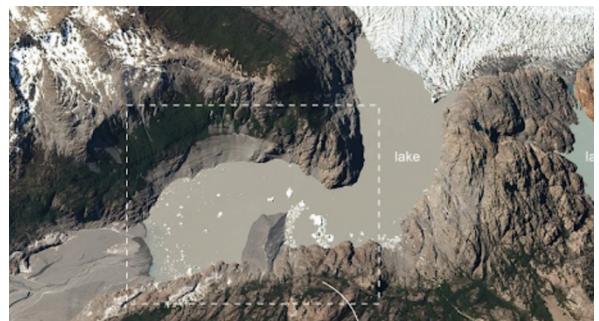
- » GLOFs are sudden fast flowing release of glacial lake water that move downslopes as a result of dam failure. They are recognized in the National Disaster Management Plan (NDMP) 2019 of India as a potential climatological disaster.

- **Glacial lakes** are either moraine dammed or ice margin dammed.

**Moraine Dam Glacial Lakes** are formed due to the retreating of glaciers, which leave behind soil and rocks and lead to an increase in capacity of lake, making it prone to bursting.



**ICE Dam Lakes** are created when ice from upper parts of glaciers fall and block passing rivers, giving rise to glacial lakes.



- **Different types of lakes may have different hazard potential:**
  - For e.g. Moraine-dammed lakes have high probability of breach and hazard potential, whereas the rock dammed lake have little chance of breach and low hazard potential.
- **Current Situation:**
  - A study, 'Glacial Lake outburst floods threaten million globally' published in the journal **Nature** in Feb 2023 highlights that:
    - **Around 15 million people globally** face the risk of GLOF.
    - Around 20% of them (**3 million**) live in India.
    - India, Pakistan, Peru and China have more than 50% of the vulnerable people.
- **Causes of increasing GLOF**
  - **Global Warming -> Climate Change**
    - Increasing number of Glacial Lakes due to acceleration of glacier melt in recent decades.
    - Increased water pressure due to more water being available due to Global Warming.
  - **Ice or rock avalanches, Erosions or other natural disruptions**
  - **Earthquakes** - Himalayan region is especially prone to earthquakes
  - **Human Activities** -> increased tourism, expansion of roads and hydropower projects, deforestation etc have also increased the vulnerability of burst in these lacs.
- **Recent Examples:**
  - **Flash Floods in Sikkim in Oct 2023** which killed 90+ people, destroyed infrastructure like bridges and roads, and damaged state's largest hydropower project, the 1.2 GW Teesta-III.
    - The flash floods were caused by access rainfall and Glacial Lake Outburst Floods (GLOF).
    - South Lhonak lake, the site of GLOF in Sikkim, was already recognized as potentially hazardous and scientists at the National Remote Sensing Centre had warned of a 42% chance of GLOF in as early as 2013.
    - **How it happened in Oct 2023:**

# WHAT CAUSED THE FLOOD IN SIKKIM



- The GLOF overflowed into Teesta river, creating flash floods that destroyed the Chungthang dam which is the key component of the state's largest hydro-electric project, and washed away highways, villages and towns. The worst affected districts are Mangan, Gangtok, Pakyong and Namchi.
  - The economic loss will be thousands of crores. Chungthang dam itself cost about Rs 14,000 crores.
- **Note:** Scientists have said that Sikkim's Glacial Lake is still at risk of GLOF, floods as there is a slight reduction in the ice area but almost half of the glacier hasn't deglaciated yet. Thus, the lake will further increase in size due to glacier melting and inflow from the North Lhonak glacier.
  - Therefore, it should be monitored to prevent another GLOF.
- The **Chamoli Flash floods of 2021** may have caused economic damages worth Rs 4,000 crore. It swept away the Rishiganga Hydel Power Project and inflicted substantial damage on the Tapovan Power Project.
- **2013 Kedarnath** flash floods was also result of GLOF.
- **Adverse Impact**
  - These floods pose **severe geomorphological hazards and risks**
    - It can wreck havoc on all man made structures located along the path and thus endanger people, infrastructure, fields and livestock.

- For e.g. the **Chamoli Flash floods of 2021** may have caused economic damages worth Rs 4,000 crore. It swept away the Rishiganga Hydel Power Project and inflicted substantial damage on the Tapovan Power Project.
- Similarly, the Kedarnath flash flood in 2013 was caused by GLOF.
- **Long term Climate Impact** may be caused by large glacial lake as they would increase the amount of water in ocean and reduce it in Himalayas.

- **Steps taken so far:**

- **CWC** has done some work towards identification of such lakes;
  - Some other aspects are still work in progress including a robust early warning system, and a broad framework for infrastructure development, construction and excavation in vulnerable zones.
- **Geological Survey of India (GSI)** carries out assessment of the GLOF threats and provide input to the National Disaster Management Authority (NDMA) for developing risk mitigation strategies.
- **National Disaster Management Authority (NDMA)** in collaboration with Swiss Agency for Development and Cooperation (SDC) have prepared **Guidelines on the Management of Glacial Lake Outburst Floods (GLOFs)** (Oct 2020)
  - The guidelines are aimed at improving the administrative responses, drawing on international best practices; and bringing together the relevant scientific capabilities of the nation to eliminate potential losses from glacial hazards.

- **Key Highlight of the NDMA Guidelines**

- i. **Inventorization: Hazard and Risk Mapping**
  - Regular monitoring of glacial lakes using satellite observations.
  - Cooperation with neighbouring countries (Nepal, Bhutan and China) to identify transboundary threats and manage it properly.
- ii. **Reduction of Hazards**
  - **Short term actions** - lowering the lake level through siphoning
    - For instance, high density PVC pipes were installed in **South Lhonak lake in Sikkim**, to reduce the pressure on the lake
  - **Long Term Actions**
    - **Artificial drainage channels** to lower lake levels
    - Reinforcement of dam
    - Enhancement of river cross section/ protection from erosion
  - **Restricting constructions and development** in GLOF prone areas is a very efficient means to reduce risks at no cost.
  - **Develop regulation for Land Use Planning** in GLOF areas.
- iii. **Reduction of Exposure**
  - Establishment of Early Warning System.
  - **Comprehensive alarm system** - including classical alarming infrastructure as well as modern technology using smart phone notifications etc.
  - Evacuation based on EWS

- Involve local population closely from the beginning in the design, planning and implementation of risk reduction and management strategies in a transparent collaboration mechanism.
- iv. **Awareness and Preparedness** through posters, social media, apps etc.
- v. **Capacity Development -**
  - Apart from specialized forces such as **NDRF, ITBP**, and the **ARMY**, the guidelines emphasize on need for trained local manpower.
  - Training of professionals and practitioners;
  - Strengthening Academic Education in relevant disciplines from natural and social sciences.
  - **Heavy earthmoving and search and rescue equipment**, as well as motor launches, country boats, inflatable rubber boats, life jackets etc.
  - Setting up **Quick Reaction Medical Teams, mobile field hospitals, Accident Relief Medical Vans**, and **heli-ambulances** in areas inaccessible by roads.
- vi. **Promote R&D in GLOF Management**
  - Promote development of **Modelling tools** to simulate the entire chain of mass movement and outburst process
  - **Historical records** should be effectively used to understand flood processes.
  - Expand the use of local knowledge, experience of local people. Engaging the local population in **joint-knowledge production** is considered indispensable for effective community based disaster risk management.
- vii. **Regulation and Enforcement**
  - A well drafted **techno-legal regime** is necessary to prevent future development of GLOF and protect existing Glaciers.
  - The regime should include a Himalaya GLOF mitigation Policy, no habitation and construction zones; and provisions for strict implementation.
- **Other steps**
  - Need of a **nodal agency** to coordinate all the researches related to glaciers in the region .
  - Fighting Climate Change
  - **Sustainable Development**
    - Restricting Tourism in these areas or promoting only sustainable tourism
    - **Detailed Project Reports and Environmental and Social Impact Assessment** needs to take into account the **Glaciology study** to better understand the impact of these projects on glaciers and glacial lakes.
  - **International Cooperation:** GLOF risk is transboundary in nature, thus there is an urgent need for a comprehensive regional risk governance framework including India, Nepal, Bhutan etc

## 4) URBAN FLOODS

- **Practice Questions**
  - The frequency of urban floods due to high intensity rainfall is increasing over the years. Discuss the reason for urban floods, highlight the mechanisms for preparedness to reduce the risk during such events. [12.5 marks, 200 words] [CSE Mains 2016, GS3]
  - Major cities in India are becoming vulnerable to flood conditions. Discuss [12.5 marks, 200 words] [CSE Mains 2016, GS1]

- Account for the huge flooding of million cities in India including the smart ones like Hyderabad and Pune. Suggest lasting remedial measures [CSE Main 2020, GS1]
- Urban floods are a result of ecological disturbance and socio-political apathy. Discuss [15 marks, 250 words]

- **Introduction**

- Recent instances of floods such as the one in Bengaluru in Sep 2022, Chennai in 2015 and Mumbai in 2005 illustrate the increasingly vulnerability of Indian cities to this disaster. A complex set of factors have worked together to deteriorate the condition of our cities and increase their susceptibility to this devastation.

- **Main Causes of Urban Floods**

i. **Unplanned Urban Development:**

- **NDMA Report: Increasing Concretization** of city land reduced the seepage of water in the ground and has increased the runoff.
- **Loss of Natural flood storage** in urban areas by filling of ponds and lakes to reclaim land for development.
  - For instance, in Chennai the number of water bodies have come down to less than 50 from 600 in 1980s. This became a major cause of 2015 floods.
  - Similarly, Bengaluru had 1,452 water bodies in 19th century, this has now reduced to only 193 lakes.
  - Here about 10,787 acres of lakes worth Rs 1.5 lakh crore has been encroached upon.
- **Encroachment of Flood Plains** of the rivers have led to loss of natural flood storage.
  - 2013 Uttarakhand floods
- **Rapid urbanization** has led to massive changes in land use patterns, as residential areas had sprung up in farmlands

i. **Improper and Inadequate Drainage system**

- A lot of sewerage and drainage network is old and lack volume to carry flood water.
  - » For e.g. The current drainage system of Delhi is based on the 1976 master plan.
- **Poor Desilting and blockage of drainage systems**. This was the main reason for 2005 Mumbai floods and a major factor in Sep 2022 Bengaluru floods.
  - » **Improper Waste Management** leads to a lot of solid waste blocking the drains. This hinders the flow of water during rainfall and contributes to floods.

iii. **Global Climate Change** have led to change in weather pattern which is sometimes causing unusually heavy rainfall thus causing floods in urban areas.

- For e.g. On 5th Sep 2022, Bengaluru received 131.3 mm of rainfall.

iv. **Social and Political apathy**

- **Religious practices** such as dumping of religious symbols, dead bodies etc. in rivers also lead to blocking of rivers. Inefficient management of gathering like Kumbha contribute to unnecessary concretization and thus floods.
- **Socio-economic factors** contribute to illegal encroachment of flood plains by slums etc. which increases the intensity of the urban floods.

- At the same time we have seen **an absence of political will** to give priority to the issue. This has happened both at national and international level.
- This lack of political will has resulted into paucity of funds which delays the key drainage infrastructure
  - The river water information sharing has remained a major issue between India-Bangladesh and India China.

#### - Consequences

- **Human and Infra Loss** - deaths and devastation; loss of telecommunication, road and railway lines; increased probability of disease epidemic
- **Economic Losses:**
  - » Other than economic losses because of destruction of infrastructure, floods result in traffic jams, temporary closure of business, destruction of property etc. which leads to loss of manhours, hindering of economic activities etc.
- **Environmental Pollution**
  - » Urban floods also lead to washing away of various pollutants including industrial waste into water bodies thus intensifying river pollution.

#### - Way forward

- **Promote the ideas of Sponge Cities** -> **Urban planning should keep in mind the geological and hydrological cycle:** Planned Development of cities should ensure that flood plains are not encroached upon, sinks like ponds are protected/restored and pavements are porous to allow infiltration of rainwater in the ground.
  - » There should be increased focus on these goals through an **Mission on Sponge Cities**.
- **Improvement of drainage system.**
  - » Proper maintenance, desilting of existing drainage system
  - » Providing alternative drainage path for flood waters (may be underground)
  - » Control of solid waste entering the drainage systems through proper Solid Waste Management
- **Change in social attitude of Common Citizen** will go a long way in controlling urban floods
  - » Reduction of solid waste, promoting environment friendly religious practices can all contribute towards limiting urban floods.
- **Disaster preparedness**
  - » Even after all proper steps, nature may cause havoc and cause floods, therefore a **proper disaster management plan** should be prepared by the ULBs to be battle ready in emergency situations. Fresh Hazard profiles should be created for the cities based on the historic as well as recent flood vulnerabilities.

#### - Conclusion

- We must not allow nature, human conduct, and urbanisation to be mystified and rendered as trans-historic villains. We can learn to live with nature, we can regulate human conduct through the state, and we can strategically design where we build. We need to urgently rebuild our cities such that they have the sponginess to absorb and release water without causing so much misery

and so much damage to the most vulnerable of our citizens, as we have seen in case of Mumbai, Chennai and Bengaluru.

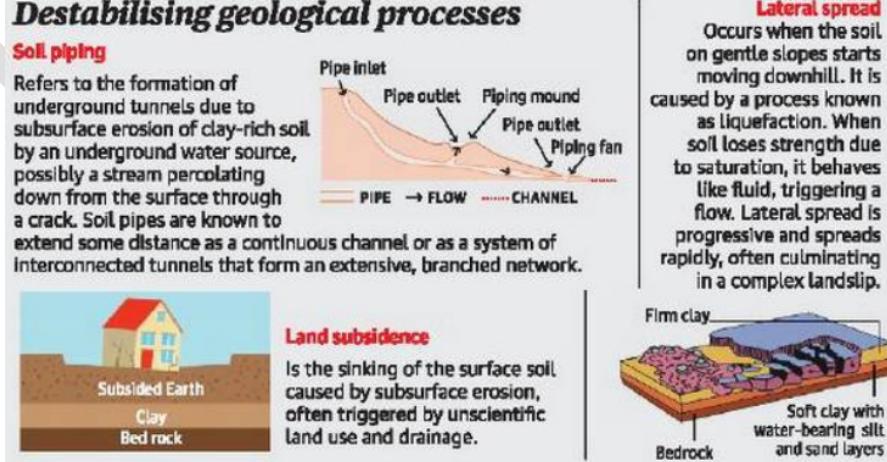
## 5) CLOUD BURST

- **Practice Questions:**
  - Explain the mechanism and occurrence of cloudburst in the context of the Indian subcontinent. Discuss two recent examples. [Mains 2022, 10 marks, 150 words]
  - Cloudbursts are often associated with flash floods. Explain the relationship between cloudbursts and flash floods, and discuss the challenges in managing flash flood events. [10 marks, 150 words]
- **What is cloudburst?**
  - A cloudburst refers to an extreme amount of rain that happens in a short period, sometimes accompanied by hail and thunder. IMD defines it as unexpected precipitation exceeding 10 cm per hour over a geographical region of approximately 20-30 sq km.
    - For e.g. the 2013 floods in Kedarnath were caused by Cloud Burst. In 2021, Amarnath region was impacted by cloudburst.
  - **Impact:** This sudden discharge of rain leads to floods including flash floods, landslides etc. which may result into human casualties, and property loss.
- **Mechanism: How does cloudburst occur?**
  - When cumulonimbus clouds (which stretch to even 13-14 kms in height) are trapped over a region or there is no air movement for them to disperse, they discharge over a specific area.
    - Here, saturated clouds ready to condense into rain can't produce rain, due to the upward movement of the very warm current of air.
    - Instead of falling downwards, raindrops are carried upwards by the air current. New drops are formed and existing raindrops increase in size. After a point, the raindrop are too heavy for the cloud to hold on to, and they drop down together in a quick flash
- **Other key aspects:**
  - It is very difficult to forecast the event due to its very small scale in space and time.
    - To monitor or nowcast (forecasting few hours of lead time) the cloudburst, we need to have dense radar network over the cloudburst-prone areas or one need to have a very high resolution weather forecasting models to resolve the scale of cloudburst. Doppler radar can be very useful in predicting them.
  - **Mountain regions are more prone to cloudburst due to orography (terrain and elevation)**, though they may occur in plains as well.
- **Way forward:**
  - **Hazard zonation mapping:** Identifying the areas vulnerable to flash floods.
  - **Improving forecasting (nowcasting) Infrastructure:** Increasing the coverage of doppler radars. Currently Himalayan region has 7 doppler radars (2 each in J&K and Uttarakhand, 1 each in Assam, Meghalaya and Tripura).
  - **Building flood resistant infrastructure:** To reduce damages due to flash floods
  - **Regulating settlements** in the river banks
  - **Strengthening institutions** to provide quick response at the time of cloudburst in the form of emergency evacuation, medicine etc.

- **Conclusion:**
  - By taking steps to predict, prepare, and respond to these events, we can reduce the loss of life and the property damage that they cause.

## 4. LANDSLIDES

- **Why in news?**
  - Landslide near Gangtok in March 2023
  - Around 50 people died due to landslide in Makhuam village of Manipur's Noney district on June 30, 2022. These people were working on the railway project (June 2022)
- **Example Questions**
  - While the **Himalayan region was always vulnerable to landslides**, the recent years have seen the peninsular hills also becoming increasingly prone to this natural disaster. Give reasons. What are the NDMA guidelines for management of landslides? [15 marks, 250 words]
- **Introduction**
  - Landslide is defined as the **movement of a mass of rock, debris or earth down a slope**. This is a type of mass wasting, which denotes any down-slope movement of soil rocks under the direct influence of gravity.
  - The term "landslide" encompasses five modes of slope movement: Falls, topples, slides, spreads, and flows.
  - There are **two landslide hotspots** that exist in India - along the **southern edge of the Himalayan arc** and the **Western Ghats region**.
- **Key causes of landslides:**
  - **Himalayas** are prone to landslides because of several **morphological and geological factors** like:
    - Tectonic movement
    - Glacial movements
    - Freeze and thaw effect
    - Unstable rock structure
    - Steep slopes etc.
      - Most regions with more than 20 degrees are prone to landslides.
    - Types of rocks, weaknesses, zone of rupture etc.
- **Destabilizing Geological Processes - Soil Piping, Land Subsidence, Lateral Spread etc.**



- But in recent years, we have also seen the stable Peninsular Hills like in Western Ghats becoming vulnerable because of the human made factors.
- **Human Induced Causes**
  - o **Climate Change: Extreme Rainfall Events trigger slope failure** where lateral spread and soil piping have occurred.
    - For instance, unusually high rainfall in Kerala since Aug 2018 has destabilized the already vulnerable hill slopes in the high ranges and has caused many landslides.
  - o **Illegal Mining, deforestation etc** have made the **surface weak and vulnerable to landslides**
    - For e.g. the railways have blamed two successive land slides along their project site in Manipur on the traditional practice of Jhum or shifting cultivation.
  - o **Unscientific Farming and Construction Activities**
    - UNDP's assessment after the 2018 flood says that changes in land cover, blocking of natural drains, and poor agricultural practices such as monocropping have all exacerbated the risk of landslides in Kerala.
    - Since 19th century, 50% of the land with tropical forests and grasslands has been converted to monoculture plantations and agricultural fields.
  - o **Illegal landgrab** using fake deeds have contributed to unscientific land use and thus landslides.
  - o **Inadequate Early Warning Systems** makes the impact of the disaster worse.
- **Government Efforts and Way Forward**
  - o **A national landslide susceptibility map** has been created by Geological Survey of India (GSI) under the **National Landslide Susceptibility Mapping Project.** This national landslide susceptibility map should be integrated with infrastructure development and planning in hilly areas.
  - o Union Ministry of Earth Science has also **initiated steps to establish a network of landslip monitoring stations** in the highlands.
    - » The units which will be based on acoustic emission technology will also have an early warning mechanism to alert the local community.
  - o **NDMA guidelines for management of Landslides**
    - » **Inventorization and regular update**
    - » **Landslide Susceptibility Map** at macro and meso scales
    - » **Awareness Generation and preparedness** among various stakeholders through setting up of institutional mechanisms.
    - » **Capacity Building to deal with Landslides**
      - Enhancing education and training of professionals involved in landslides management.
      - Capacity development of organizations working in the field of landslides
    - » **Create an Autonomous National Centre** for landslide studies research and management.
  - o **Other steps that can be taken**
    - » **Deploy Early Warning Systems** based on rainfall thresholds in various vulnerable regions.
  - o **Note: In way forward also suggest** things like increase afforestation, banning of mining in sensitive areas, sustainable forms of agriculture etc.

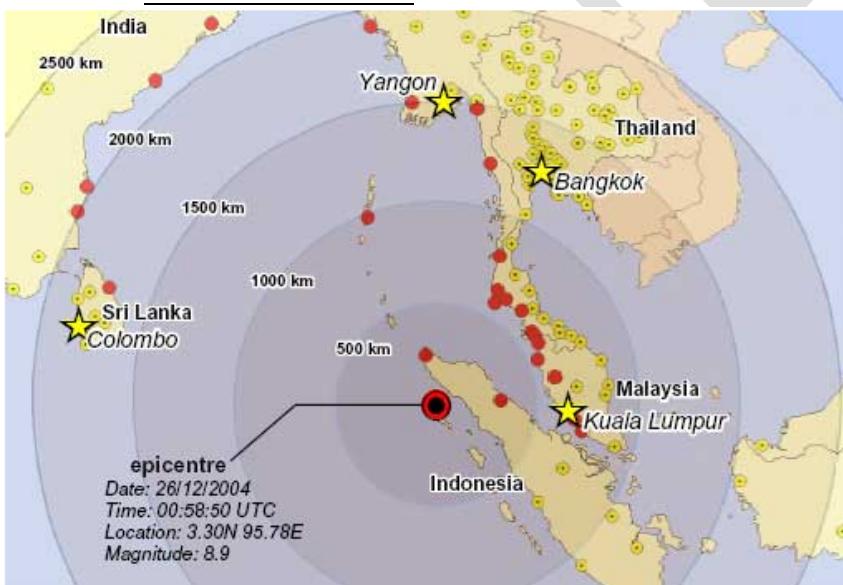
## 5. TSUNAMI

### - Example Questions

1. On December 2004, tsunami brought havoc in 14 countries including India. Discuss the factors responsible for the 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. [15 marks, 250 words][CSM 2017]
2. Discuss the key steps taken by India towards Tsunami Disaster Preparedness since the 2004 Tsunami? [10 marks, 150 words]

### - Introduction

- The term Tsunami has been derived from the Japanese term 'Tsu' meaning harbour, and 'nami' meaning waves. Thus tsunami means 'harbour waves'..
- Tsunami consist of a series of waves which rise as high as 10 meters or more. They move inland, several hundred kms causing untold disasters. These waves move at great speed and sometimes they move even 50 km/h on the coastal plains.
- **26th Dec 2004 Tsunami/Great Sumatran Andaman Earthquake / Asian Tsunami / Boxing Day Tsunami**
  - An undersea earthquake occurred on Dec 26, 2004, with an epicenter off the west coast of Sumatra, Indonesia. The earthquake triggered a series of devastating Tsunamis along the coasts of most of the countries bordering the Indian Ocean. 225,000 people were killed in 11 countries.



- The earthquake which triggered the Tsunami was of a magnitude between 9.1 to 9.3 on the Richter scale. It is second largest earthquake ever recorded on a seismograph. This earthquake lasted for about 10 minutes. It caused entire planet to vibrate as much as 1 cm and triggered other earthquakes as far as Alaska.

### - Causes of Tsunami

1. **Earthquake** of more than 6.5 on the Richter Scale, with a vertical disruption of water column due to vertical tectonic displacement of the sea bottom along a zone of fracture in the earth's crust is the most important cause of Tsunami.

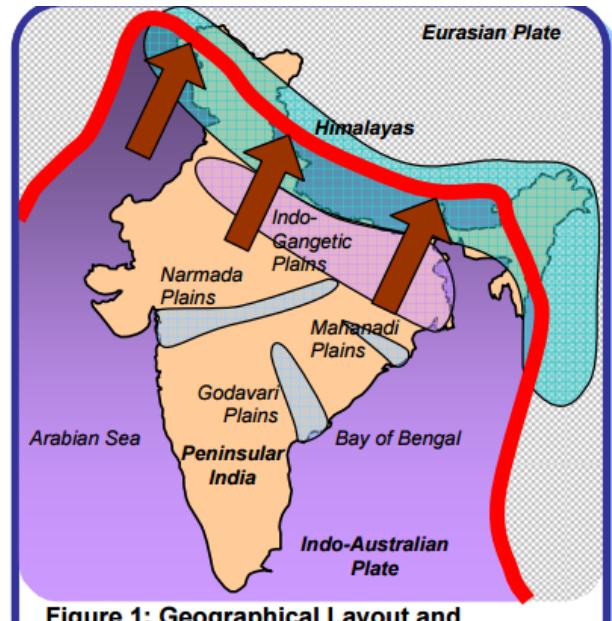
2. **Volcanic Eruption**, and **submarine landslides** are other reasons which may displace water and cause it to inundate coastal region.
  3. **Nuclear Explosion**, **fall of large celestial bodies** (like asteroid, meteorites, comets etc can also cause Tsunami)
- **Tsunami Detection**
    - i. **Different Ways to detect Tsunamis – Coastal tidal gauges, Satellite technologies; deep ocean assessment and report** (using pressure changes)
    - ii. **State Preparedness Measure Before Tsunami**
      - Hazard Mapping: Identify Tsunami prone areas
      - Establishment of Early Warning System
      - Educate people in these regions about Tsunamis - inform them about the evacuation routes in case a Tsunami hits the coast.
      - Mock Evacuation drills should be conducted periodically so that people are aware of it
      - Capacity Building to deal with Tsunami disaster
      - Provisions for sufficient provisions during emergency
      - Land use planning and engineering solutions
        - Increasing plant biodiversity along the coast.
    - iii. **Preparedness by citizens**
      - Live at safe distance from coastline; in elevated houses; well managed drainage system; easy access to information system like TV radio etc; following SOP during Tsunami.
    - iv. **Tsunami Response**
      - **People on Land:** After warning sound move to safer places with cattles (top floor of the multi-storied buildings); stay away from rivers that flow into the oceans; Listen to radio and TV for updates regularly.
      - **People on Sea:** Don't return to coast; if time is available move to deeper waters;
      - **Government:** Search and rescue; basic services like water, first aid etc.
  - **Nodal Agency for Tsunami Forecast:** Indian National Center for Oceanic Information Services (INCOIS)
  - **Steps taken by India Since 2004 Tsunami:** The **2004 Tsunami highlighted the clear lack of preparedness** about Tsunamis all over the world. None of the affected countries, including India had any system for early warning of such Tsunamis, nor was there any plan for emergency response. Learning a lesson from 2004 Tsunami, GoI have taken a number of steps:
    1. **Early Warning System:** GoI has established the state-of-art India Tsunami Early Warning Centre (ITEWC) (operational since 2007) at the Indian National Centre for Ocean Information Services (INCOIS) as an autonomous body under Ministry of Earth Sciences.
    2. INCOIS has extended **GIS-based 3D protocol on Tsunami warning to all vulnerable areas** in the country with new methodologies and improved warning procedures.
    3. **Strengthening Tsunami Research** has been a key focus of GoI since 2004.
    4. **National Disaster Management Guidelines** for management of Tsunami, 2010
    5. **Regular Mock Drills** are conducted by NDMA, INCOIS and Ministry of Home Affairs

- These exercises help familiarize participants with their responsibilities, actions required and further help them evaluate the Standard Operating Procedure (SOP) for Tsunami warnings.

## 6. Awareness generation programs in coastal area is also conducted regularly since 2004.

### - Steps that we further need to take

- Improve EWS: Advanced technology such as Artificial Intelligence and Machine learning should be incorporated to improve the Early Warning System in the country.
- Increased International Collaboration in real time monitoring will help support each other during emergencies.
  - BIMSTEC can play a very important role in promoting this collaboration in Bay of Bengal region.
- Regular training and Capacity building through workshops, drills etc. can help us avoid the 2004 scenario.
- Land use planning is one area which has been mostly ignored.
  - There is a requirement of more vegetation cover in coastal region, but various studies have shown that mangrove cover has gone down over the years.
- Removing the limitations of India's disaster management institutional framework



**Figure 1: Geographical Layout and Tectonic Plate Boundaries at India**

## 6. EARTHQUAKE

### - Introduction

- India lies at the northwestern end of the Indo-Australian Plate, which encompasses India, Australia, a major portion of the Indian Ocean and other smaller countries.
- The major reason for the high frequency and intensity of earthquakes is that Indian plate is driving into Asia at a rate of approximately 47 mm/year.
- According to NDMA, about 59% of India's land could face moderate to severe earthquakes.

### - Different zones

- Bureau of Indian Standards, based on the past seismic history, grouped the country into four seismic zones, viz. Zone-2, Zone-3, Zone-4 and Zone-5. Of these, Zone 5, is the most seismically active region, while zone 2 is the least.
- The Modified Mercalli (MM) intensity, which measures the impact of the earthquakes on the surface of the earth, broadly associated with various zones, is as follows :

#### ▪ Seismic Zone Intensity on MM Scale

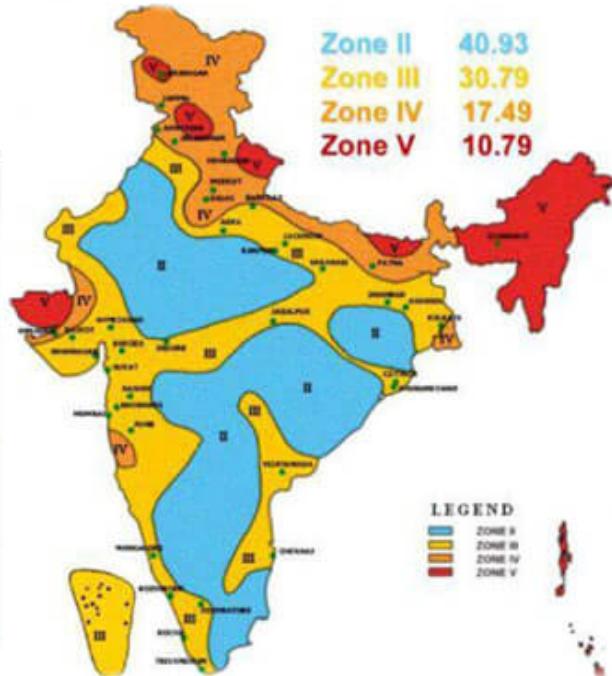
Seismic Zone Intensity	MM Scale
Zone - V ( Very High Intensity zone)	IX (or more)

Zone -IV (Severe Intensity Zone)	VIII
Zone - III (Moderate Intensity Zone)	VII
Zone - II (Low Intensity Zone)	VI (or less)

- **Zone 5:** Areas with highest risk; suffers earthquakes of intensity MM IX or greater; IS code assigns zone factor of 0.36 for Zone 5.
  - **Regions in India:** Parts of J&K, Himachal Pradesh, Uttarakhand, Parts of North Bihar, Entire North eastern region, and Andaman and Nicobar Islands.
- **Zone 4:** Areas within High Damage Risk Zone and covered areas are liable to MM VIII; IS code assigns a zone factor of 0.36 for Zone 4
  - **Regions in India:** Parts of J&K and Himachal Pradesh, UT of Delhi, Northern Part of UP, Bihar and Bengal, Sikkim, Parts of Gujarat, Small Portion of MHA near the west coast and Rajasthan.
- **Zone 3:** Classified as Moderate Damage Risk Zone; liable to MM VII; IS code assigns zone factor of 0.16 for zone 3.
  - **Regions in India:** Kerala, Goa, Lakshadweep islands, and remaining parts of Uttar Pradesh, Gujarat and West Bengal, parts of Punjab, Rajasthan, MP, Bihar, Jharkhand, Chhattisgarh, Maharashtra, Orissa, Andhra Pradesh, Tamil Nadu and Karnataka.
- **Zone 2:** The region is assigned low damage risk. The IS code assigns zone factor of 0.10 (maximum horizontal acceleration that can be experienced by a structure in this zone is 10% of gravitational acceleration) for Zone 2.
  - **Region:** Rest of India.
- **Zone 1**
  - Since the current division of India into earthquake hazard zones does not use Zone 1, no area in India is classed as Zone 1.

**Seismic Zone, Map of India 2002**  
About 59 percent of the land area of India is liable to seismic hazard damage

Zone	Intensity
Zone V	Very High Risk Zone Area liable to shaking intensity IX (and above)
Zone IV	High Risk Zone Intensity VIII
Zone III	Moderate Risk Zone intensity VII
Zone II	Low Risk Zone VI (and lower)



### - Causes of Earthquakes

- The important causes of earthquakes can be divided into two categories: Natural and Manmade

#### i. Natural Causes

1. **Tectonic Movements**
2. **Volcanic Activities**
3. **Adjustment in the inner rocks beds (Plutonic Earthquakes)**
  - Adjustment between Sima and Sial in the interior of the earth's crust.
4. **Pressure of Gases in the interior**
  - The expansion and contraction of gases in the interior of the earth sometimes cause a sudden shake on the earth's surface
5. **Other causes**
  - Landslides and avalanches
  - Denudation of landmasses and deposition of materials

#### ii. Man-made causes

1. **Dams:** Impounding of large quantity of water behind the dams disturb the crustal balance and can cause earthquakes
2. **Nuclear Bombs**
  - The shockwaves through the rocks set up by underground testing of Atom bombs or Hydrogen bombs may be severe enough to cause an earthquake.

#### iii. Causes which make India very vulnerable

- Fragile built environment (Similar sized earthquake in Japan or USA will cause much smaller damage)

### - Consequences of Earth Quakes

- Human and livestock loss
- Damage to Property
- Tsunamis
- Change in river course - floods
- Fountain of muds
- Landslides

- **NDMA Guidelines for Management of Earthquake: Six Pillars of Earthquake Management in India**
  - a. Ensure the incorporation of earthquake resistant design features for the construction of new structures.
  - b. Facilitate selective strengthening and seismic retrofitting of existing priority and lifeline structures in earthquake-prone areas.
  - c. Improve the **compliance regime** through appropriate regulation and enforcement.
  - d. Improve the **awareness and preparedness** of all stakeholders.
  - e. Introduce **appropriate capacity development interventions** for effective earthquake management (including education, training, R&D, and documentation).
  - f. **Strengthen the emergency response capability** in earthquake-prone areas
- **Earthquake hazard Reduction and Mitigations**
  - Earthquake is a natural phenomenon which is **difficult to prevent and therefore we can only prepare for the earthquake and post-earthquake response**. The foreknowledge of potential danger areas can help mitigate the impact of a disaster.
- **Steps that needs to be taken**
  - **Short Term Steps:**
    1. **Preparing Vulnerability Map** of the country
      - Establishing infrastructure for early warning system in vulnerable areas.
    2. **Strengthening Early Waring Infrastructure** -> for providing those crucial extra seconds of a minute in disaster scenario.
    3. **Strengthening Institutional Framework** -> Shortage of manpower in SDRF and NDRF should be rectified. Local governments, NGOs etc also need to be prepared for post disaster response especially in vulnerable areas.
    4. **Implementing Building Codes** -> Municipalities need to ensure that BIS codes and guidelines are properly being followed in new buildings.
      - The lifeline buildings which have been built in the past and are not earthquake resistant needed to be upgraded by retrofitting techniques
    5. **Improving building code** through a new architecture regime and this be made mandatory for all builders and developers.
    6. **Educating people** through dissemination of information about the ways and means of minimizing the adverse impacts of earthquakes. Dissemination of techniques such as 'Drop, Cover and Hold' is very important reducing the loss of life during earthquakes.
      - **Community preparedness** is very important for dealing with earthquake. Though we have NDRF and other bodies to do search and rescue operations, but experience shows that most of the time it is the community which plays the first

hand role in disaster situation and therefore they have to be given proper training regarding search and rescue as well.

- Community should have a disaster emergency kit ready for disaster situation
  - Community also needs to participate in planning, implementation and monitoring process of any method being used.
- **Long Term steps:**
    1. **International Collaboration**
      - We should collaborate with other countries in development of earthquake resistant infrastructure. Our collaboration with countries like Japan will be very crucial in enhancing our preparedness for earthquakes.
    2. **Decongesting of Cities** to reduce risk and vulnerabilities
- **Conclusion**
    - Earthquake may not yet be predictable and certainly not preventable, still if effective and timely steps are taken, the adverse impact of Earthquakes can be considerably blunted.
- ## 7. HEATWAVES - ALREADY COVERED IN PREVIOUS BOOKLETS
- **Why in news?**
    - » Many Heat wave deaths in Uttar Pradesh and Bihar (June 2023)
    - » Earlier in April 2023, **13 people died from apparent heatstrokes** while attending a government award function in an open space in Navi Mumbai. This is possibly the biggest ever heatwave-related death toll from a single event in the country, and brings back to spotlight on potential risks from heatwaves, whose intensity and frequency is expected to rise because of climate change.
  - **Example Questions**
    - » What are heat waves? Suggest a strategy to reduce India's vulnerability to heatwaves. [15 marks, 250 words]
    - » With a focus on the Oct 2019 guidelines from the National Disaster Management Authority (NDMA), discuss the mechanisms for preparedness to deal with Heat Waves in India. [15 marks, 250 words]
    - » Heatwaves can pose economic challenges to various sectors. Evaluate the economic consequences of heatwaves on industries such as agriculture, tourism, and energy, and suggest some measures to minimize their adverse effects [15 marks, 250 words]
  - **Definition**
    - A heat wave is a **period of abnormally high temperatures, more than the normal maximum temperature** that occurs during the summer season usually in the north-western parts of India. In India, heat waves typically occur between March and June, and in some rare cases extend till July.
    - **Indian Meteorological Department (IMD)** has given following criteria for heat waves.
      - **Maximum Temperature of at least 40 degree Celsius for Plains, 37 degree Celsius for coastal regions** and atleast **30 degree Celsius for hilly regions**.
  - Following conditions are used declare heat waves:

- a. **Based on Departure from Normal**
  - **Heat Wave:** Departure from normal is 4.5 degree to 6.4 degree
  - **Severe Heat Wave:** Departure from normal is > 6.4 degree
  
- b. **Based on Actual Maximum Temperature (for plains only)**
  - **Heat Wave:** When actual maximum temperature  $\geq$  45 degree Celsius
  - **Severe Heat Wave:** When actual maximum temperature  $\geq$  47 degree Celsius.
  
- **Note:** Heat wave has not been notified as a disaster by the Government of India yet and hence is not eligible for relief under National/State Disaster Response Fund norms.
  
- **Increasing cases of Heat Waves in India:** According to Lancet Report, India faced 60 million heatwave exposure events in 2016, a rise from 40 million exposures in 2012. Similarly, the average length of heat waves in India ranged from 3-4 days, which is more than double of global average of 0.8 - 1.8 days. The key factors responsible for this are:
  - » **Climate change -> higher temperatures**
    - According to a report by UNICEF "*The Coldest year of the Rest of Their Lives*" - nearly every child will face frequent heatwaves by 2050.
  - » **Sparser Pre Monsoon shower and Delayed Monsoon**
    - This weather pattern coupled with El-Nino effect, which often increases temperature in Asia, combine to create the record high temperatures.
  - » **The Loo (hot and dry winds) originating from Pakistan and Northwest India**, has also contributed to increasing temperature in India.
  - » **Urbanization and its problems like Urban Heat Island (UHI) Effect** exacerbates the problem of heat wave in many parts of our country.
  - » **Decreasing Tree Covers ->** concrete jungles, land heats up more.
  
- **Impact of Heatwaves**
  - » **Health Impacts**
    - The heat waves are associated with increased rate of heat stress and heat stroke, worsening heart failures and acute kidney injury from dehydration.
    - Children, elderly and those with pre-existing morbidities are particularly vulnerable.
    - According to NDMA, more than 24,000 people have died in India due to heat waves between 1992-2015.
  - » **Economic Loss**
    - According to Lancet, the output of workforce in India declined by 7%, equivalent to 75 billion labor hours every year.
  - » **Worsening of air pollution problems** -> increased electricity use -> more fuel burned.
  
- **Steps Taken So Far**
  - » The **IMD** has regularly issued heat wave warnings in different parts of the country to make people aware of the worsening situation.
  - » The **NDMA** has suggested things like covering of head, cross-ventilating rooms and sleeping under a slightly wet sheets.

- **NDMA's revised guidelines for prevention and management of Heat Waves in India (Oct 2019)**
  - » **Aim/Objective**
    - The guideline aims to provide framework for developing Heat Action Plans for implementation, inter-agency coordination and impact evaluation of heat wave response activities in cities/towns.
  - » **Developing a Heat-wave Plans**
    - Generating heat wave risk and **vulnerability map and mapping hotspots** for developing a strategic mitigation action plan.
    - Identifying **Vulnerable Population** - elderly, pregnant women, chronic disease patient, resident of a particular type of housing, certain type of occupations etc.
    - **Identification and Evaluation of factors** leading to disproportionate increase in temperature in the city
  - » **Reducing Temperature** in the cities through vertical gardens, small parks with water fountains etc.
  - » **Coordinate with Research institutions** for better built environment.
    - Government budget should allocate funds for R&D in this field
  - » **Curb Future UHI manifestation** by incorporating findings from the built environment assessment
  - » Adhere to city building codes.
  - » **Preparedness at the local level** for health eventualities.
  - » **Health care system capacity building**
  - » Collaboration with private and Non-Government and Civil Society
  - » Establish Early Warning System and Communication Systems
  - » Developing inter-agency response plan and coordination in the field.
- **Other Steps that can be taken:**
  - » **Preparedness:** Already discussed with NDMA guidelines
  - » **Response:**
    - Ensuring quick advanced communication and guidelines during heatwave condition.
    - Drinking water supply should be increased along the roadside during heatwave conditions
    - Health facilities should respond with all the relevant facilities.
- **Other steps:**
  - » **Reviewing the existing occupational health standards, labor laws, and sector regulation** for worker's safety.
    - **Special focus on farm laborers** as the agricultural sector was more vulnerable compared to the industrial and service sectors because workers there were more likely to be exposed to heat.
  - » Increased work on amenities like increased access to drinking water, indoor ventilation, healthcare, regular work breaks, and protection against wage loss.
  - » **Promoting more greenery throughout the city** especially on both sides of the roads to ensure cooler roads.
  - » **Making communities more aware and resilient** to after effects of the heatwaves.

- » Internationally, the **global community** should work towards achieving the **climate change mitigation goals** by working towards Paris Climate targets and making the NDCs more ambitious.

## 8. DROUGHTS

- **Important Quotes:**
  - » "Indians know that the Monsoon is the real finance minister of India" - Environmental Activists Sunita Narain
- **Intro**
  - » Drought is a period of below average precipitation in a given region, resulting in prolonged shortages of its water supply, whether atmospheric, surface water or ground water. A drought can last for months or for years.
- **Types of droughts**
  - » **Meteorological drought** is brought about when there is a prolonged time with less than average precipitation. Meteorological drought usually precedes other kinds of drought.
  - » **Agricultural droughts** are droughts that affect crop production or ecology of the range. They are caused by shortfall in water available to the crops. It can be caused by extended period of low precipitation, poor water management, soil erosion or other such situations.
  - » **Hydrological drought** is brought about when water reserves available in sources such as aquifers, rivers, lakes and reservoirs fall below the statistical average. Hydrological drought tend to show up more slowly because it involves stored water that is used but not replenished. Like an agricultural drought this can be triggered by more than just a loss of rainfall.
  - » **Socioeconomic droughts** occur when water shortage starts to impact people's lives, individually and collectively.
- **Causes**
  - » **Natural Factors**
    - **Precipitation deficiency**
      - **El Nino Southern Oscillation:** All the severe meteorological and hydrological droughts between 1870-2018 were found to be caused due to positive phase of ENSO (El Nino Southern Oscillation)
      - Lack of pre-Monsoon shower. For e.g. in 2019, India witnessed the second driest pre-monsoon season in 65 years.
    - **Dry Season**
    - **Land Degradation** - Desertification, erosion etc.
  - » **Anthropological factors**
    - **Poor water management**
      - Subsidies on equipment and electricity usage has encouraged over-exploitation of ground water.
      - Surfeit of dams have wreaked havoc on riverine system.
      - Poor rainwater conservation - Currently India captures only 8% of its rainfall - one of the lowest in the world.

- Too much focus on **water consuming power generation** (like coal based power plants)
  - **Agricultural inefficiencies** - Agriculture consumes more than 90% of India's water use. 80% of this water is used for water guzzling crops like rice, wheat and sugarcane. Further, less penetration of technologies like drip irrigation and other forms of micro-irrigation also leads to inefficient water utilization.
  - **Improper and Unsustainable implementations of Watershed Development Programs**
  - **Water pollution** - India ranks 120th among 122 countries in a global water quality index.
  - **Climate Change** - The global temperature is already higher by more than 1 degree Celsius from the pre-industrial era. This has also contributed in the spell of drought in India. For instance, drought continued in India post 2016 despite a change from El-Nino conditions due to climate change.
- **Impacts of Droughts in India:** For a developing country like India where more than 50% of the population is still dependent on agriculture, the drought comes as a bane. The negative impact of drought can be summed up under the following heads.
  - i. **Physical - Geographical-Environmental Impact:**
    - Meteorological drought adversely affects the recharge of soil moisture, surface runoffs and ground water. Rivers, lakes, ponds etc. tend to dry up.
    - **Exacerbates ground water extraction and depletion**
    - Increases **water and soil pollution** - for instance deeper borewell have higher chances of arsenic and fluoride contamination.
  - ii. **Economic Impact:** According to MoEF&CC - desertification, land degradation and drought cost India nearly 2.5% of GDP in 2014-15.
  - iii. **Impact on Agriculture** - Large percentage of agriculture rain dependent -> reduction in agri output
    - shortage of food and other agri-produce -> **inflation**
    - Reduced farmers income -> **increased farmer distress** -> increased farmer suicide
  - iv. **Other Economic and Social Impacts**
    - **Water Security:** Scarcity of drinking water -> **Health issues**
    - **Energy supply** may get impacted if the country increases its dependency on hydropower. (Note: India gets 17% of its electricity from Hydropower)
    - **Loss of livelihood** -> **unemployment** -> **Poverty** -> **Distress migration to cities, sale of property & livestock**
    - **Slowing down of secondary and tertiary activities** due to fall in agricultural production and decline in purchasing power.
    - **Increasing inequality** -> Drought hampers weaker section of society including farmers, landless workers, weavers, artisans etc.
    - **Social stress and tension**, disruption of social institutions and increase in social crime
      - Growth in superstition, increasing belief in supernatural powers etc.
  - v. **Increased inter-state and International river water dispute** -
    - e.g. the Cauvery water dispute between Karnataka and Tamil Nadu exacerbated during less rainfall year.
    - E.g. the disputes between India and China for the water distribution of 10 major rivers originating in Tibet

- **How is Drought Declared in India**
  - According to the Manual for Drought Management 2016 - **two factors** are considered for drought:
    - i. The extent of rainfall deviation (depreciation)
    - ii. The consequent dry spell
  - **Four indicators are used to assess the extent of drought**
    - Agriculture, Remote Sensing, Soil Moisture and Hydrology
    - Each impact indicator has various levels of severity
  - **For severely drought-hit** - at least 3 of the four indicators must indicate drought
  - **For Moderate drought-hit** - at least 2 (in addition to rainfall) must check out
  - **If only one indicator** (in addition to rainfall) checks out, the area is not considered to be drought affected.
  - **Impact of Drought Declaration**
    - In case of severe category of drought, assistance can be got from **National Disaster Response Fund** for mitigation and relief.
  - **Concerns of States**
    - States are unhappy with the recent drought manual as it has made it difficult to establish severity of drought and would drastically reduce assistance from the Centre's National Disaster Relief Fund (NDRF).
    - Sometimes only 10-20% of the state's area is under drought. In such cases Center has overlooked the severity of drought in a limited area and the state gets no assistance from the National Disaster Response Fund.
- **Drought Relief Measures / Coping with droughts**
  - Management of drought has now been outlined in much elaborate manner in the drought manual issued by the ministry of Agriculture and Cooperation.
    - **Drought Monitoring:** Continuously monitoring rainfall situation and the available water in various lakes, rivers, tanks etc. This will help us to plan better for the impending drought scenario.
    - **Contingency Crop Planning:** All the stakeholders need to prepare the contingency crop plan and disseminate it among farmers with the help to support agencies, mentioned below. The alternative crop planning involves choosing suitable crops and/ or crop varieties, alternative crop strategies, mid season's corrections and crop life saving measures.
    - **Relief Employment:** The most important relief component is the generation of employment provision during drought period. Extension of MGNREGA, Food for Work program of various states etc. can play a big role in relief employment.
    - **Water Resource Management** - One of the most critical task of relief operations - measures such as augmentation of water supply, rationing of water use, and efficient utilization and management of water resources, in both urban and rural areas
    - **Food Security** is one of the most important objective of drought management. It is provided through food for work programs etc.
    - **Relief through tax waivers and concessions**

- **Cattle Camp and Fodder Supply:** State governments need to support their farmers in protecting their cattle population during a drought situation by providing necessary assistance for fodder, feed, and cattle health. During the drought situation, every measure needs to be taken to save useful cattle. If the cattle wealth is depleted recovery will be slow.
  - **Health and Hygiene:** During drought health issues related to contamination of water and spread of infection among workers of public work program has been seen. Health relief is also an important component of drought relief.
  - **Institutional Response**
    - Drought management requires a strong institutional structure to monitor and provide a timely response to drought. While it is primarily the responsibility of the state government to manage drought, the central government also plays an important role in monitoring drought and providing financial assistance to the states.
    - The **district administration headed by the collector** plays the most critical role in responding to drought on the ground. At the central level, the ministry of Agriculture is the department responsible for drought monitoring and management.
  - **Role of Panchayati Raj Institutions**
    - It is necessary to include PRIs in all the operations as they are more connected to ground and have better understanding of the regional problems.
  - **Information management and Media Coordination**
    - The Central and State governments should provide information on all aspects of drought to people and media. It is necessary to inform the people about the severity and impact of drought and the measures being taken to alleviate the drought situation.
  - **Some Limitations of Drought Management in India**
    - Drought management continues to be inadequately addressed in India due to **improper planning and coordination** between different functioning units and **poor implementation** at the ground level.
      - There is a **lack of focus on long term sustainability and livelihood issues** and quick fix solutions are resorted too
    - **The process of declaration of drought** has been made **long and difficult** by the drought manual issued by central government in 2016.
      - This prevents timely relief measures like drinking water supply, subsidized diesel and electricity for irrigation, increasing number of days of work under MGNREGA etc.
- **Way Forward**
1. **Scientific mapping of Drought Prone areas**
  2. **A system of Early Warning** at least in drought-prone areas
  3. **Robust methodology for Drought declaration**
  4. **Holistic and Sustainable Development of Watershed** with community participation.
  5. **Efficient utilization of water in Agriculture** - since it accounts for 80% of India's water use
    - Awareness programs regarding the efficient use of water

- Using advanced improved methods of irrigation like micro-irrigation - sprinkler and drip irrigation.
  - **Change in cropping pattern.**
    - Awareness
    - Reform in MSP regime - to cover more millets, pulses, oilseeds etc.
  - **Rationalize electricity charges** for farmers - to prevent overuse and overexploitation of ground water.
6. **Preservation of Rain water in both Urban and Rural Areas** - Rainwater harvesting, Recycling of treated water.
- Improve and Implement building codes to promote water conservation and rainwater harvesting.
7. **Afforestation**
- It ensures water retaining capacity of the soil and also increases the chances of rainfall.
8. **Paris Agreement Targets**
- National Action Plan on Climate Change and State Action Plan on Climate Change needs to get into implementation mode very quickly.

## 9. DAM SAFETY

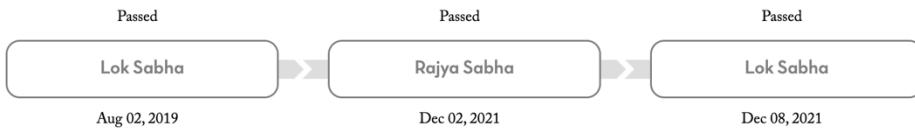
- **Why in news?**
  - In Oct 2023, Sikkim's highest Dam (Teesta-III Dam at Chungthang) was washed away after an GLOF which raised doubts about hydropower projects being developed in the country (Oct 2023)
    - Various reports have since revealed that there were no EWS, no risk assessment or preventive measures in place as required under the 2021 Dam Safety Act.
- **Example Questions**
  - Discuss the key provisions of the Dam Safety Act 2021. How far does it go in ensuring structural and operational safety of dams [12.5 marks, 200 words]
  - What are the key concerns related to Dam Safety in India? How far will the Dam Safety Act, 2021 be able to resolve these concerns? [10 marks, 150 words]
- **Introduction**
  - Dams are playing a very important role in the development of India. They not only supply water for irrigation, but also contribute in flood control and Energy generation (around 17% of India's total electricity).
  - In terms of **number of Dams**, India stands third in the world with more than 6,000 large dams in operation and another 400+ large dams under construction. Further, India has thousands of medium and small dams.
  - However, a **poorly maintained and ill-operated dam** can become a source of threat not only for human life and infrastructure, but also for the environment. Therefore, there has been a long felt need of a **uniform law and administrative structure** in the country for the purpose of dam safety.
- **Key concerns associated with Dam Safety in India**

- » **Very Old Dams** - around 4% (227) of large dams are more than 100 years old and 80% are more than 25 years old.
- » Many of these dams are located in earthquake prone zones.
- » India has faced 36 major dam failure in the past, the worst one of Machchhu Dam (Gujarat) in 1979 in which about 2000 people had died.
- » There are **varying degree of inadequacies** in meeting the current standards of dam health and safety.
  - **Poor Implementation** of the existing safety provisions
  - A report by CAG has found that
    - The structural strength of 348 large dams are suspect and they have not been inspected for over a decade.
  - Similarly, the **world bank report on Dam Rehabilitation and Improvement Project (DRIP) indicates** that the implementation of the program has been moderately unsatisfactorily.

- **Institutional Framework/Programs/Schemes dealing with dam safety in India**

- **The Central Water Commission**, Ministry of Jal Shakti through the National Committee on Dam Safety (NCDS), NDSO, SDSCO etc has been making constant endeavours in the direction of Dam Safety.
- **Dam Rehabilitation and Improvement Project (DRIP)** is being implemented by Ministry of Jal Shakti with assistance from World Bank.
  - The main objectives of DRIP are:
    - TO improve the safety performance of selected existing dams (223 dams across 7 states) in a sustainable manner
    - To strengthen the dam safety institutional set up in participating states as well as at central level.
  - The seven DRIP states are - Uttarakhand, Madhya Pradesh, Jharkhand, Odisha, Karnataka, Kerala and TN.
- **The Dam Health & Rehabilitation Monitoring Application (DHARMA)**
  - It is a webtool/app which is focused on digitizing dam related data effectively. It will help in easy identification of vulnerable dams and ensure need based rehabilitation.
- **Ministry of Power and DRDO have signed an MoU for vulnerable Hydro Projects/ Power Stations in Hilly Areas**
  - Under this they would work jointly together towards developing suitable mitigation measures against avalanches, landslides, glaciers, glacial lakes, and other geo-hazards
  - For vulnerable projects in hilly areas, expertise of DRDO will be used for developing comprehensive EWS.

## 1) DAM SAFETY ACT, 2021



- The act is aimed at helping states and UTs to adopt uniform safety procedure and thus ensure safety of the dams. It also gives statutory backing to various dam safety institutions and provides for strict punishment in case of the violation of the law.
- It provides for surveillance, inspection, and maintenance of all specified dams across the country.
  - » These dams are with height more than 15 meters, or height between 10 meters to 15 meters but with certain design and structural principle.
  - » The act establishes a **robust Institutional Framework for Dam Safety**.
    - It sets up **two national bodies**
      - i. **The National Committee on DAM SAFETY** which would evolve policies and recommend regulations regarding dam safety.
      - ii. **The National Dam Safety Authority** which would implement policies of the National Committee, provide technical assistance to State Dam Safety Organizations (SDSO) and resolve matters (dispute resolution) between SDSOs of states or between SDSOs and Dam Owners.
    - » The law also sets up **two state bodies**
      - i. **State Committee on Dame Safety** which will review work of SDSO, order Dam Safety Investigation, recommend dam safety measures and review the progress of such measures.
      - ii. **State Dam Safety Organization (SDSO)** will be responsible for surveillance, inspection, monitoring, operation, maintenance and investigation of dams.
- **Jurisdiction over dams**
  - » All specified dams will fall under jurisdiction of the SDSO of the state in which dam is situated.
  - » For dams owned by CPSU or which extends in two or more states or when a dam owned by one state is situated in other state, NDSA will have the jurisdiction and will play the role of SDSO.
- **What are states required to do?**
  - » Provisions require states to classify dams based on hazard risk, conduct regular inspections, create emergency action plan, institute emergency flood warning systems, undertake safety reviews and period risk assessment studies.
- **Duties and Functions of DAM owners** ( sufficient funds, trained manpower, dam safety units to conduct regular inspections, mandatory presence of engineers during floods and emergency, install emergency flood warning system; carry out risk assessment at regular intervals)
- **Comprehensive DAM Safety Evaluation (CSE)**
  - The act provides for comprehensive safety evaluation by independent panel of experts at regular intervals.
- **Offences and Penalties** for violation of provisions

- **Analysis of the act : Key challenges/Limitations**
  - **Jurisdiction of Parliament on the issue** (**Entry 17 of the State List read with Entry 56 of the Union List**, gives powers to state to make laws on water supply, irrigation and canals, drainage and embankments, storage etc for intra state rivers) .
  - The **functions** of the NCDS, NDSA, SCDS are listed in the schedule of the act which can be modified by government through notification. Experts have raised concerns over this kind of overwhelming powers with central government.
  - **States Raising Concerns** regarding NDSA having jurisdiction over dams owned by one state but situated in others. Some states feel that this takes away rights of states over their dams.
    - Note: TN own dams in the state of Kerala (in Mullaperiyar, Parambikulam, Tunakadavu, and Peruvanipallam)
  - **States lack technical capability** to really implement the act in terms of number of trained personnel's, engineers etc.
    - The Sikkim GLOF reveals poor compliance at all levels of dam safety, from the dam's design to the spillway capacity.
  - **Environment Impact ignored**
    - The act does not contain any norms which relates to environmental impact in the upstream and downstream of the rivers.
  - **Lack of focus on operational safety** (like rate of filling or rate of water release) could lead to continuance of cases of Dam induced floods (e.g. Kerala floods, 2018)
- **Other problems related to Dam**
  - **Lack of coordination between states** leads to faulty management of dams.
    - For e.g., the recent floods in Odisha was caused by faulty management of Hirakud Dam. One of the reasons for it was lack of information from Chhattisgarh to Odisha regarding the flow of water.
- **Way forward**
  - **Set up the institutional framework envisaged under the law**
    - **Dam Safety Policy** should be finalized quickly to act as a guiding principle towards protection of Dams.
  - **Promote More transparency:**
    - Dam Safety is a public purpose and thus everything about dam safety, functions of institutions, their reports, decision minutes and agendas, everything should be promptly available to public.
  - **Human Resource development:**
    - We will need huge human resource for ensuring that trained people man dams, engineers are available for inspection and monitoring, emergency action plan etc.
  - **Land use plans** should have dam safety issues integrated in it.
  - **Operational Safety and Environment Impact** needs to be better integrated in the act and any future policies.
  - **Increased coordination between states:**
    - E.g. of the **United States web-based integrated risk management tool** called Dam Sector Analysis tool. The tool was developed using variables from dam failure models and decision support systems, which enables the software to project downstream risk in the case of a dam failure.

**- Conclusion:**

- India's first prime minister, Pandit Jawaharlal Nehru, had referred to dams as the 'temples of modern India'. These temples would remain a boon, only if all the stakeholders work towards eliminating risks associated with Dam Safety.