VISIONIAS
INSPIRING INNOVATION

ENVIRONMENT & DISASTER MANAGEMENT

VALUE ADDED MATERIAL

MAINS 2025

Key Features:

In-Depth PYQ Analysis: Identifies key trends for efficient prep.

One-Stop Solution: Consolidates all topics in one resource.

Integrated Current Affairs: Incorporates latest updates.

Chronologically Ordered for Clarity: Structured for progressive learning.

ENVIRONMENT AND DISASTER MANAGEMENT

Student Notes:

Contents

Student Notes:

Student Notes:

Preface

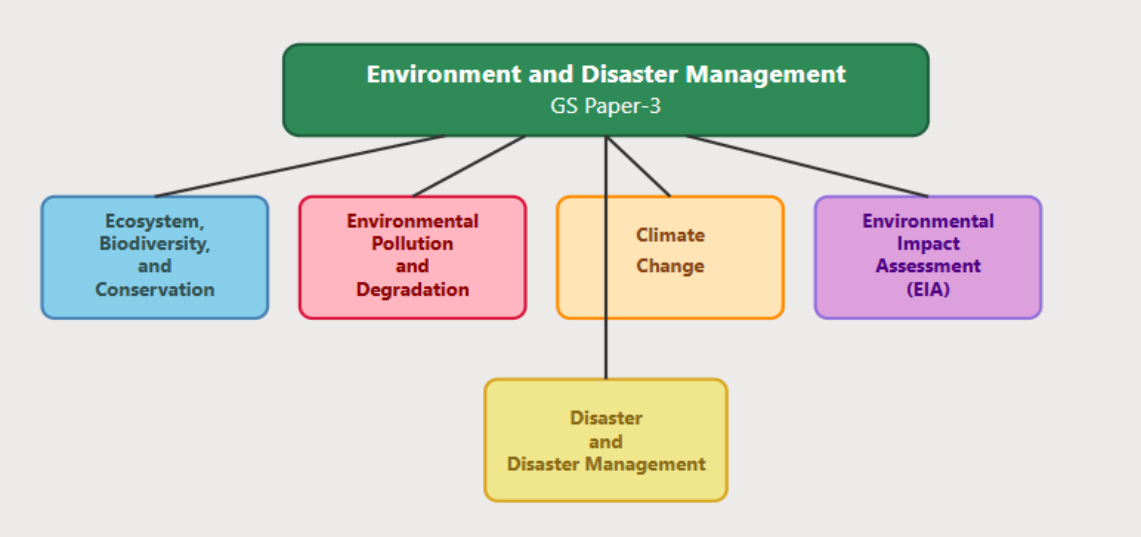
Student Notes:

Dear Aspirant,

Congratulations on navigating the intricate Prelims stage of the Civil Services Examination. The journey to Mains demands not only a robust knowledge base but also a nuanced understanding of interconnected subjects, especially in dynamic areas like **Environment and Disaster Management**.

We recognize that this critical phase can be daunting. With a syllabus that constantly evolves, driven by global conventions, national policies, and emerging environmental challenges, you might find yourself grappling with questions like: How do I cover the vast spectrum of topics, from foundational ecological concepts to the latest climate agreements? How do I effectively integrate static knowledge with current developments to craft high-scoring answers?

It is with a deep appreciation for these challenges that we, the team at VISIONIAS, have meticulously prepared this Environment and Disaster Management Value Added Material (VAM) for Mains 2025. This document is not merely a compilation; it is a strategic guide designed to empower your preparation for the GS Paper 3.



The Philosophy: Precision, Relevance, and Dynamic Integration

The cornerstone of this VAM is a thorough and objective analysis of UPSC Mains questions from recent years. This rigorous PYQ analysis, present at the beginning of each subtopic, serves as the guiding principle, ensuring that every aspect of the document is aligned with the examination's demands.

How Will This Document Empower Your Mains Preparation?

Our primary objective is to equip you with the comprehensive content and the analytical acumen necessary to excel. This VAM is structured to achieve several key objectives:

- **Elaborate PYQ Analysis:** Each subtopic within the document begins with an in-depth analysis of Previous Year Questions, helping you grasp the core demands of UPSC and prioritize your study effectively.
- **Chronologically Ordered for Clarity:** The content is presented in a logical and chronological sequence, facilitating easy understanding and retention, building concepts progressively from foundational principles to advanced applications.
- **Comprehensive Coverage:** We have meticulously covered major conventions, rules, and acts pertinent to both environmental protection and disaster management, providing a consolidated resource for these crucial legal and policy frameworks.

- **Integrated Current Aspects:** Recognizing the dynamic nature of this subject, recent amendments, landmark judgments, and the latest climate conventions and agreements are seamlessly integrated throughout the document, ensuring your preparation is always up-to-date.
- **One-Stop Solution:** This comprehensive document addresses the entirety of the syllabus, consolidating all necessary topics into a single, accessible resource, thereby saving your valuable time and effort in navigating multiple sources.

Our Commitment to Your Success

This document is a culmination of dedicated effort aimed at simplifying your preparation and maximizing your output. We firmly believe that with a clear strategy and the right resources, your diligent efforts will translate into commendable success. Trust this process, utilize this material to its fullest potential, and approach the examination hall with the confidence that you are thoroughly prepared.

Student Notes:

1. ECOSYSTEM, BIODIVERSITY AND CONSERVATION

Student Notes:

Previous Year Questions (PYQ's)

1. Comment on the National Wetland Conservation Programme initiated by the Government of India and name a few India's wetlands of international importance included in the Ramsar Sites. (2023)
2. Explain the causes and effects of coastal erosion in India. What are the available coastal management techniques for combating the hazard? (2022)
3. Coastal sand mining, whether legal or illegal, poses one of the biggest threats to our environment. Analyze the impact of sand mining along the Indians coasts, citing specific examples. (2019)
4. Define the concept of carrying capacity of an ecosystem as relevant to an environment. Explain how understanding this concept is vital while planning for sustainable development of a region. (2019)
5. What is wetland? Explain the Ramsar concept of 'wise use' in the context of wetland conservation. Cite two examples of Ramsar sites from India. (2018)
6. How does biodiversity vary in India? How is the Biological Diversity Act, 2002 helpful in conservation of flora and fauna? (2018)

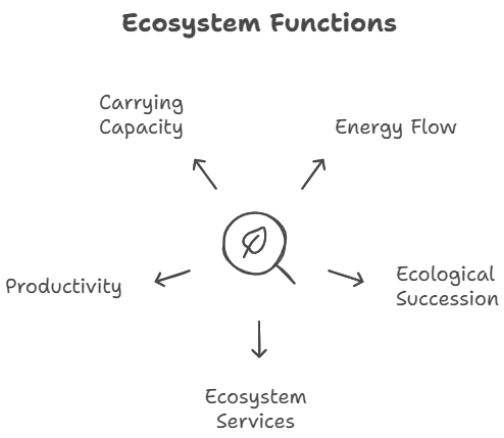
PYQs Analysis

UPSC's questions on this theme combine **ecological concepts with policy applications**, often focusing on India's biodiversity-rich and ecologically sensitive areas. The trend reflects an integration of environmental theory, legal frameworks, and examples.

- **Wetlands & Conservation Policy:** Questions in 2018 and 2023 emphasize the significance of wetlands, Ramsar Convention's 'wise use' principle, and national programmes like NWCP, highlighting UPSC's focus on India's international environmental commitments and wetland management.
- **Coastal Ecosystems & Human Impact:** The 2019 and 2022 questions probe issues like sand mining and coastal erosion, showcasing interest in the degradation of coastal zones due to unsustainable practices and the need for scientific coastal management (e.g., CRZ norms, ICZMP).
- **Biodiversity, Laws & Sustainability:** Conceptual questions on carrying capacity and biodiversity variation (2018, 2019) highlight the relevance of ecological balance, while also testing awareness of laws like the Biological Diversity Act, 2002 and sustainable development planning.

1.1. Ecosystem

An ecosystem is a community of **living organisms (biotic components) interacting with their non-living physical and chemical environment (abiotic components)** as a functional unit. It represents a complex web of relationships where energy flows and nutrients cycle.



1.1.1. Function of Ecosystems

Ecosystems are dynamic entities performing vital processes that facilitate life and maintain balance.

1.1.1.1. Energy Flow

Energy flow begins with producers capturing sunlight, transferring it through **trophic levels** (feeding positions).

- **Food Chains** show linear energy transfer (e.g., grass → deer → tiger).
- **Food Webs** are complex, interconnected food chains, providing ecosystem stability.
- **Ecological Pyramids** graphically represent trophic levels by number, biomass, or energy, typically showing a decrease at higher levels. The **10% Law** states only about 10% energy transfers to the next trophic level.

1.1.1.2. Ecological Succession

Ecological succession is the gradual change in the species structure of an ecological community over time. **Primary Succession** occurs in barren habitats (e.g., bare rock), while **Secondary Succession** occurs in disturbed areas where soil already exists (e.g., after a forest fire).

Stages of ecological succession

- **Pioneer Stage:** Initial colonization by first hardy species in a new or disturbed area.
- **Seral Stages:** Intermediate communities that progressively replace each other over time.
- **Climax Community:** The stable, mature, and self-perpetuating final community for a given climate.

Importance of Ecological Succession

Ecological succession is important for several reasons:

- **Ecosystem Recovery:** It is a fundamental process for the natural recovery and regeneration of ecosystems following disturbances like **fires, floods, or volcanic eruptions**.
- **Building Resilience:** Succession contributes to the **long-term stability and resilience of ecosystems**, allowing them to adapt and persist in changing environmental conditions.
- **Biodiversity Dynamics:** It drives changes in species composition and diversity over time, leading to the development of **more complex and mature communities**.
- **Guiding Conservation:** Understanding successional pathways is crucial for effective conservation and restoration efforts, enabling **targeted interventions** to aid the recovery of degraded habitats.

1.1.1.3. Ecosystem Services

Ecosystem services are the diverse benefits humans derive from healthy ecosystems, crucial for well-being.

- **Categorizing ecosystem services**
  - **Provisioning Services:** Products from ecosystems (e.g., food, fresh water, timber).
  - **Regulating Services:** Benefits from ecosystem processes (e.g., climate regulation, water purification, pollination).
  - **Cultural Services:** Non-material benefits (e.g., recreational, spiritual, aesthetic).
  - **Supporting Services:** Services necessary for all other services (e.g., nutrient cycling, soil formation).

1.1.1.4. Productivity in Ecosystems

Productivity refers to the **rate at which biomass is produced** in an ecosystem. It quantifies the amount of energy accumulated per unit area over a given time period.

- **Gross Primary Productivity (GPP):** This is the **total rate at which solar energy is captured** by producers (like plants) through photosynthesis.
- **Net Primary Productivity (NPP):** This represents the **energy remaining after producers account for their own respiration** (energy used for metabolic activities). NPP is the energy available to the next trophic levels in the ecosystem.

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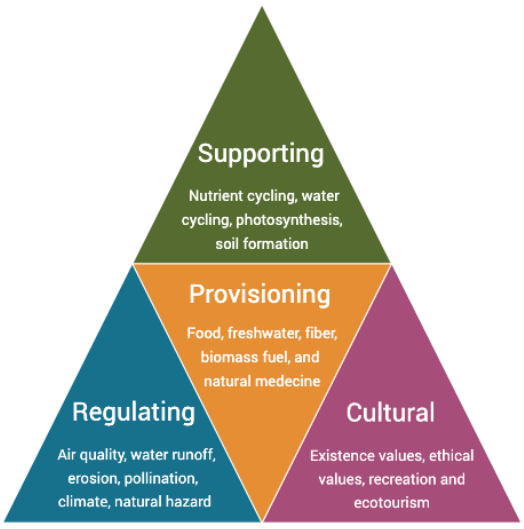
1.1.1.5. Carrying Capacity of an Ecosystem

Carrying capacity is the maximum population size of a species an environment can sustain indefinitely, considering available resources and waste assimilation.



1.1.1.6. Human Impact and Sustainability Concerns

For human populations, exceeding an ecosystem's carrying capacity leads to severe consequences:

- **Accelerated Resource Depletion:** Over-demand strains finite natural resources, manifesting as acute water scarcity, rapid land degradation, and depletion of vital natural capital.
- **Intensified Pollution Burden:** Population growth and unsustainable consumption patterns overwhelm natural waste assimilation capacities, leading to increased air pollution, water contamination, and unmanaged solid waste accumulation.
- **Ecosystem Degradation & Biodiversity Loss:** Persistent pressure from human activities pushes ecosystems beyond their regenerative limits, resulting in habitat destruction, fragmentation, and a significant loss of biodiversity.
- **Reduced Quality of Life:** The cumulative effect of resource scarcity and pervasive pollution directly impacts human health, livelihoods, and overall societal well-being, diminishing the quality of life.

1.1.2. Threats Faced by Ecosystems

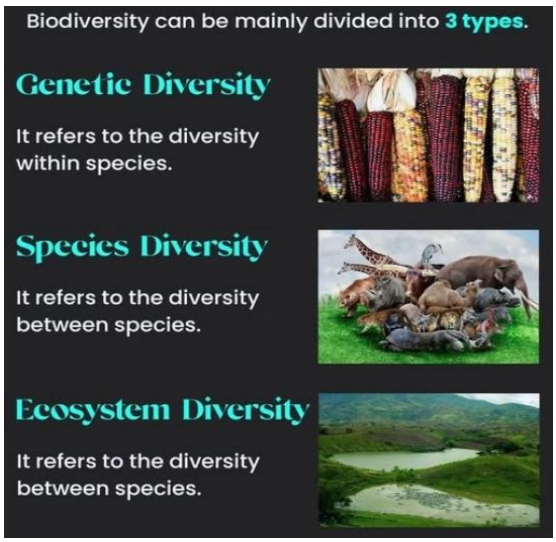
Ecosystems globally face numerous threats, largely driven by human activities:

- **Habitat Loss and Fragmentation:** The destruction and division of natural habitats (**e.g., deforestation for agriculture or urbanization**) is the leading cause of biodiversity loss, directly impacting species and ecosystem integrity.
- **Pollution:** Contamination of air, water, and soil with **harmful substances** (e.g., industrial effluents, plastic waste, pesticides) degrades ecosystem quality, disrupts biogeochemical cycles, and harms living organisms.
- **Climate Change:** Altered temperature regimes, changed precipitation patterns, increased frequency of extreme weather events, and sea-level rise are directly impacting ecosystem structure, function, and species distribution.
- **Invasive Alien Species:** The introduction of non-native species, either accidentally or intentionally, can outcompete native species, disrupt food webs, introduce diseases, and alter ecosystem processes.
- **Overexploitation:** Unsustainable harvesting of natural resources (e.g., overfishing, illegal logging, excessive groundwater extraction) depletes populations and degrades habitats beyond their regenerative capacity.

Transitioning from understanding ecosystems as nature's functional units, we turn to their very essence: **Biodiversity**. Ecosystem health, stability, and vital services fundamentally depend on the immense variety of life within them, from genes to species and communities. This next section will explore biodiversity's significance and the critical threats it faces.

Student Notes:

1.2. Biodiversity



Biodiversity is the variety of life on Earth, encompassing millions of distinct biological species, their genetic variation, and the complex communities and ecosystems they form.

1.2.1. Significance of Biodiversity

- **Supports Healthy Ecosystems:** Biodiversity is essential for ecosystems that provide vital services like water, pollination, soil fertility, and food. Loss of biodiversity weakens these services, impacting human life and survival.
- **Improves Human Health:** A strong link exists between biodiversity and health. Loss of biodiversity increases the risk of diseases, particularly zoonotic diseases that spread from animals to humans.
- **A Key Solution to Climate Change:** Biodiversity aids in climate change mitigation by storing carbon in forests, wetlands, and mangroves. Forests alone are responsible for 11% of global emissions; maintaining biodiversity in these areas is crucial for securing "**irrecoverable**" carbon.
- **Economic Benefits:** Biodiversity drives global economies, contributing to food production, forestry, and ecotourism industries. It also supports livelihoods, especially in developing countries where communities rely on natural resources.
- **Integral to Culture and Identity:** Many species are central to religious, cultural, and national identities. Biodiversity enriches recreation, education, and inspiration for art. Indigenous communities, in particular, hold strong spiritual connections to nature, yet often lack recognition.

1.2.2. Loss of Biodiversity

The present era is often described as the **Sixth Mass Extinction**, a period of high biodiversity loss across bacteria, fungi, plants, and animals. Unlike previous natural extinction events, this one is primarily driven by human activity, notably unsustainable use of land, water, energy, and climate change.

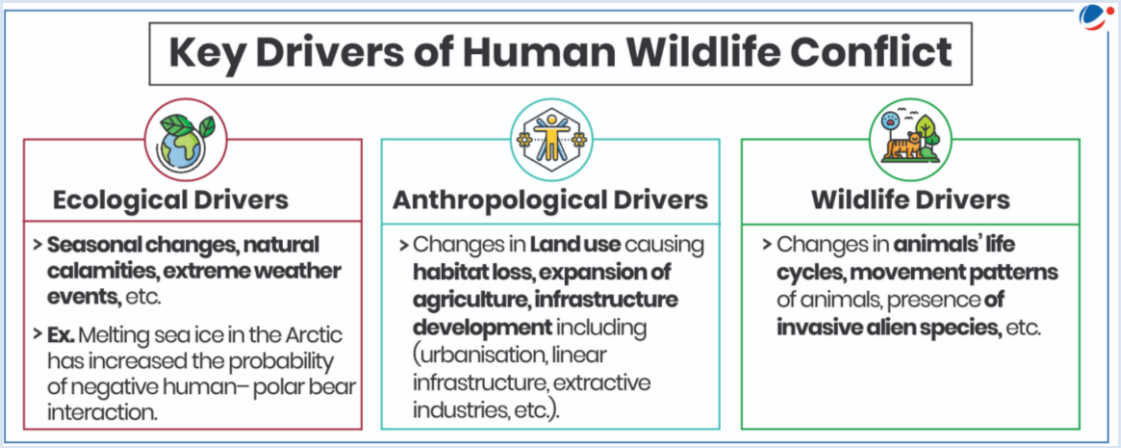
1.2.3. Causes of Biodiversity Loss

- **Habitat Loss and Fragmentation:** Destruction of habitats is the leading cause of species extinction. Tropical rainforests, once covering **14% of Earth's land, now cover only 6%**.
  - The Amazon rainforest is being cleared for agriculture and cattle ranching. Fragmented habitats, caused by roads, settlements, and canals, harm species that need large territories or migratory routes.
- **Over-exploitation:** Overuse of natural resources leads to depletion and extinction of species.
  - **Examples** include the extinction of the **Steller's sea cow**, **passenger pigeon**, and many marine fish species.
- **Invasive Alien Species:** Non-native species introduced intentionally or by accident can disrupt ecosystems and cause harm to native species.
  - **For example**, the introduction of **Nile perch** in Lake Victoria led to the extinction of unique fish species, and weeds like **Parthenium** and **Lantana** threaten native plants and animals.
- **Co-extinctions:** When one species goes extinct, species that depend on it may also disappear.
  - **For example**, if a fish species that a particular parasite depends on becomes extinct, the parasite will also vanish. Similarly, if a plant's pollinator becomes extinct, the plant may follow suit.

Student Notes:

Human- animal conflict

It refers to the struggles that emerge when the presence or behaviour of wildlife poses a threat to human interests leading to negative impacts on people and/or wildlife.



Impact of the Human Wildlife Conflict

- **Impact on Wildlife:** It threatens the survival of various terrestrial and marine species as retaliation or pre-emptive killings may drive the species to extinction.
- **Impact on Ecosystems:** It may cause damage to crops and livestock population, further disturbing the predator-prey balance.
- **Impact on Social Dynamics:** Discord among stakeholders as farmers blame government for species' protection and conservationists blame farmers and industries for clearing habitats.
- **Impact on Local Communities:** Resulting loss of lives, livestock, crops, property, is more pronounced on vulnerable, poor and marginalised communities.

Initiatives taken for mitigation of HWC

- **Creation of Protected Areas Networks:** Including National Parks, Sanctuaries, Conservation Reserves and Community Reserves all over the country under the **Wildlife (Protection) Act, 1972** to conserve wild animals and their habitats.
- **Species specific Guidelines:** Released by Ministry of Environment, Forests, and Climate Change covering 10 species like Elephant, Gaur, Leopard, Crocodile, etc.
- **Centrally Sponsored Schemes:** Like **'Development of Wildlife Habitats, 'Project Tiger' and 'Project Elephant'** where financial assistance to State/UTs is provided.
- **National Wildlife Action Plan 2017-2035 (NWAP):** Includes a dedicated chapter on managing HWC.
- **National Human-Wildlife Conflict Mitigation Strategy and Action Plan (2021-26):** Ensures harmonious co-existence and overall well-being of humans and wildlife.

Student Notes:

1.2.4. Biodiversity Conservation

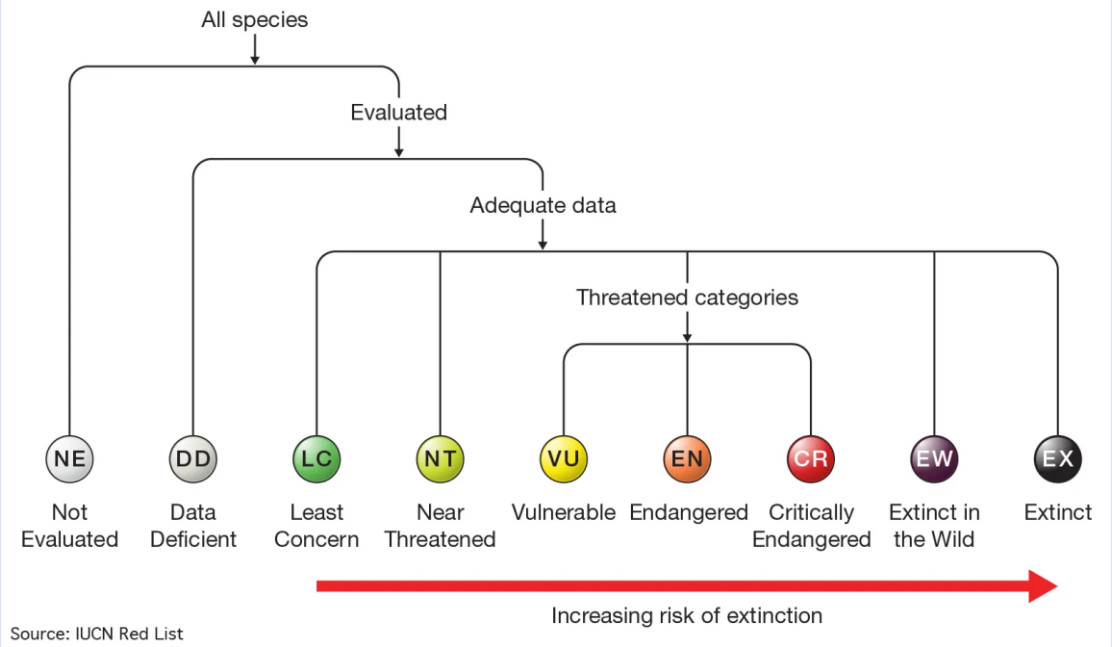
Conservation of biological diversity is crucial for preserving essential ecological diversity and maintaining the continuity of food chains.

Core Conservation Approaches

- **In-situ Conservation:** This method involves conserving animals and plants directly within their natural habitats.
  - **Examples:** Established natural habitats for in-situ conservation include National Parks, Wildlife Sanctuaries, Biosphere Reserves, Reserved Forests, and Protected Forests.
- **Ex-situ Conservation:** This approach involves conserving biodiversity outside the areas where species naturally occur.
  - **Examples:** Animals are reared or plants cultivated in facilities like Zoological Parks, Botanical Gardens, and Seed Banks.

The Red Data Book and IUCN Categories: A Global Conservation Barometer

The **Red Data Book**, issued and continually updated by the International Union for Conservation of Nature (IUCN), lists species deemed threatened. The "Red" symbolizes the danger species (plants and animals) face globally.



Constraints in Biodiversity Conservation:

- **Low Priority:** Conservation of living natural resources often receives low priority.
- **Monetary Exploitation:** Exploitation of living natural resources for financial gain often overrides conservation goals.
- **Knowledge Gaps:** Inadequate knowledge about species and ecosystems hinders effective conservation planning.
- **Development Pressures:** Unplanned urbanization and uncontrolled industrialization act as significant barriers to conservation efforts.

1.3. Initiatives for Biodiversity Conservation

1.3.1. Biodiversity hotspots

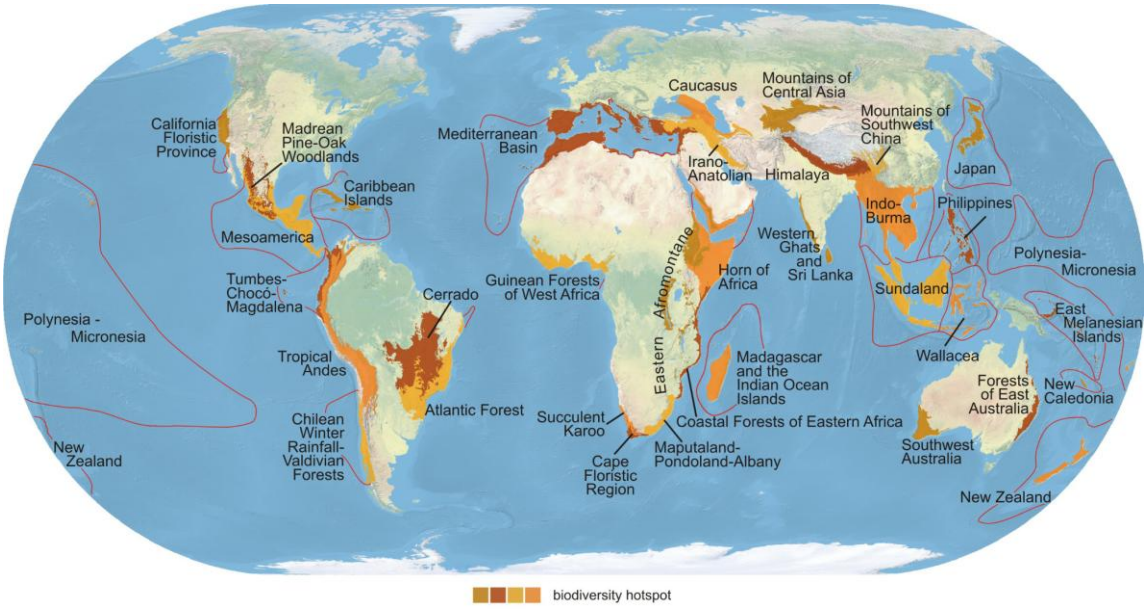
A **biodiversity hotspot** is a biogeographic region that is both **rich in species diversity** and **under threat of destruction**. These regions are recognized for their exceptional levels of biodiversity,

particularly endemic species.

Student Notes:

Criteria for Biodiversity hotspots

1. **Species Richness**: The region must have at least **1,500 species of vascular plants** as endemics.
2. **Threat Level**: The region must have lost at least **70% of its original habitat**, indicating a high level of threat and a critical need for conservation attention.



Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

1.3.1.1. Significance of Declaring a Biodiversity Hotspot

- **Global Conservation Priorities**: Designating a region as a biodiversity hotspot highlights the importance of protecting it.
- **Resource Allocation**: Hotspot status often leads to increased funding and support from governments, NGOs, and international organizations for conservation efforts.
- **Scientific Importance**: Hotspots are important areas for biological research, especially in terms of studying evolutionary processes, ecological functions, and the role of endemic species in global biodiversity.

India is home to four of the world's **36 biodiversity hotspots**, which represent some of the richest and most diverse ecosystems globally. **These hotspots are:**

- **The Western Ghats and Sri Lanka**
- **The Himalayas**:
- **Indo-Burma**
- **Sunda Shelf (Andaman and Nicobar Islands)**

Western Ghats Biodiversity hotspot

The Western Ghats Biodiversity Hotspot faces severe threats primarily from **habitat loss and fragmentation** due to deforestation and unsustainable development pressures, including mining and infrastructure projects.

Conservation Measures for western ghats

Gadgil Committee Recommendations (2011)

- **Ecologically Sensitive Areas (ESAs)**: The Gadgil Committee recommended declaring large portions of the Western Ghats as **Ecologically Sensitive Areas** (ESA), restricting developmental activities like **mining, deforestation, and construction in sensitive regions.**

Student Notes:

Kasturirangan Committee Recommendations (2013)

- **Reduction of ESA Coverage**: The Kasturirangan Committee proposed protecting **37% (from 67%)** of the Western Ghats, focusing on **ecologically critical areas** while allowing controlled development in other zones.

Joint Forest Management (JFM)

- **Community-Managed Forests**: Implementation of the **Joint Forest Management (JFM)** program, where local communities share the responsibility for forest protection and benefit from forest resources.

Biosphere Reserves

- **Biosphere Reserve Designation**: The **Western Ghats Biosphere Reserve** was established to conserve the region's diverse ecosystems, combining ecological protection with sustainable development initiatives.

Eco-bridges

Eco-bridges, also known as **eco-ducts**, are structures designed to facilitate **wildlife connectivity** that can be disrupted due to human infrastructure such as highways, railways, and logging. These bridges allow animals to safely cross roads and other barriers.

These eco-bridges are often planted with vegetation to blend seamlessly with the surrounding landscape, ensuring that wildlife movement is not impeded.

Significance of Eco-bridges:

- **Wildlife Connectivity**: They help restore and maintain natural wildlife corridors, enabling species to move freely between fragmented habitats, thus preventing the negative impacts of habitat isolation.
- **Prevention of Roadkill**: By providing safe crossing points, eco-bridges reduce the risk of roadkill, which is a major cause of death for wildlife near roads.
- **Sustainable Development**: Eco-bridges offer a practical solution to balance the need for infrastructure development with the conservation of biodiversity, allowing for continued development without further harming wildlife.

Case study of eco- bridge - Madhya Pradesh-Maharashtra Border Eco-Underpass:

This **eco-bridge** will be one of India's longest underpasses, stretching across **1.4 kilometers**. Situated on the **Madhya Pradesh-Maharashtra border**, the project is designed to support wildlife movement and enhance conservation efforts in the area.

1.3.2. Citizen movements for conservation of biodiversity

Citizen-led movements have played a crucial role in the conservation of biodiversity in India. These movements, often inspired by Gandhian principles of non-violence and self-reliance, have brought together local communities to protect natural resources from exploitation and unsustainable development.

Student Notes:

1.3.2.1. Importance of Citizen Movements

- **Empowerment of Local Communities**: These movements empower local populations, especially marginalized groups such as **women and indigenous people**, to become active participants in environmental governance.
- **Awareness and Advocacy**: Such movements raise public awareness about the importance of biodiversity and the direct link between environmental health and human well-being.
- **Influence on Policy**: They have led to substantial changes in environmental policy and legal frameworks, such as the **Forest Conservation Act** and **wildlife protection laws**.
- **Sustainable Development**: They show that development does not have to come at the cost of the environment. These movements have demonstrated that it is possible to protect ecosystems while allowing for human development, a key lesson in today's context of climate change and environmental degradation.

Some of the most notable movements include

- **Chipko Movement (1973):** The **Chipko Movement**, was a social-ecological movement initiated in the 1970s to protect forests from being felled. The movement successfully compelled the government to **ban commercial logging** in the Uttarakhand Himalayas for a period, leading to a significant reduction in deforestation in the region.
- **Appiko Movement (1983):** Inspired by the success of the Chipko Movement in northern India, the **Appiko Movement** took root in **Karnataka** in 1983. The term "Appiko" means "hug" in **Kannada**, reflecting the movement's core principles of direct action and tree conservation.
- **Anti-Tehri Dam Movement (1980s-1990s) :** The **Tehri Dam** project, a major multipurpose dam on the **Bhagirathi River** in Uttarakhand, sparked significant opposition due to its potential environmental and social impact.

These movements remind us that citizens, particularly grassroots communities, are at the forefront of the fight to protect nature. Their collective efforts are invaluable in fostering sustainable environmental practices and influencing national and global environmental policy.

Student Notes:

1.3.3. Nature Based Solution

Nature-Based Solutions (NbS) refer to the sustainable management and use of natural ecosystems to address societal challenges, such as biodiversity loss, climate change, water scarcity, and food security.

Some key Nature-Based Solutions for biodiversity conservation:

- **Restoration of Degraded Ecosystems**: Restoring degraded forests, wetlands, mangroves, coral reefs, and grasslands helps revive ecosystems and biodiversity. For example, **mangrove restoration** helps protect coastal areas from erosion, provides habitat for fish and birds, and enhances carbon sequestration.
- **Establishing Protected Areas**: Creating national parks, wildlife sanctuaries, and biosphere reserves protects ecosystems and wildlife from human encroachment. These areas provide safe havens for threatened and endangered species.
- **Agroforestry**: Integrating **trees into agricultural systems** helps enhance biodiversity by providing habitats for species and improving **soil fertility and water retention**. This method also contributes to carbon sequestration and climate resilience.
- **Mangrove and Seagrass Restoration**: Mangroves and seagrasses provide vital ecosystem services such as **carbon storage, coastal protection, and nursery habitats for fish**. Protecting and restoring these ecosystems is essential for maintaining marine biodiversity.
- **Controlling Invasive Species**: Invasive species often threaten native biodiversity. NbS includes managing invasive species through physical removal, biological control, or restoring native habitats to outcompete invasives.

1.4. Legal Measures for Biodiversity conservation

1.4.1. Wildlife Protection Act, 1972

Major Features

- Defines **wildlife categories (Schedules I–VI)** with varied protection levels.
- Enables declaration of **sanctuaries, national parks, biosphere reserves**.
- Regulates **capture, trade, transport, hunting**, and **scientific/educational use** of wildlife.
- Establishes key enforcement bodies: **Forest/Wildlife Wardens**, **NTCA**, **WCCB**, and **NBWL**.
- Permits **controlled hunting** under strict conditions (Section 11) and allows central/state **wildlife rule-making** authority.

Positives vs Issues

Positives	Issues & Examples
Offers **strong legal protection** for wildlife, including most endangered species.	**Illegal trade enforcement** remains weak—e.g., seizure of 100+ birds & turtles in Jalaun.
Basis for establishing **Protected Areas**—sanctuaries, parks, corridors.	**Human–wildlife conflict** rising; Kerala seeks amendments for culling (boars, macaques)
Empowers **WCCB & NBWL** for national wildlife action & enforcement.	**Urban wildlife management** poor—illegal use of langurs in Gurgaon & fatalities.
Includes provisions for **controlled hunting** via permits under Sec 11.	**Enforcement abuses**: Kerala blacklists snake catchers for unscientific methods & price gouging.
Flexible—has been **amended/specified** (e.g., new licensing rules in 2024 & updated Schedules in May 2025)	**State–Centre tensions**—states press for amendments but Centre resists giving more powers.

Student Notes:

Way Forward

- **Strengthen enforcement & documentation**
  - Roll out uniform crime-recording formats across all states (Odisha model)
  - Increase prosecution capacity and conviction rates.
- **Clarify culling & conflict protocols**
  - Issue guidelines on using Sec 11 permits statewide.
  - Combine conflict zones mapping, community engagement, and insurance schemes.
- **Urban wildlife policy overhaul**
  - Ban use of langurs, standardize rescue & rehabilitation in urban zones.
  - Expand veterinary & rescue infrastructure.
- **Update Schedules & licensing transparency**
  - Review species lists regularly; study ecological impacts.
  - Strict oversight on trade licensing; streamline central & state roles.
- **Leverage technology & awareness**
  - Utilize AI, remote sensing for poaching detection and habitat monitoring.
  - Educate citizens on wildlife laws, human–wildlife coexistence strategies.

1.4.2. National Wildlife Action Plan (2017–2031)

Guided by provisions of the Wildlife (Protection) Act, 1972, Forest (Conservation) Act, 1980, and Biological Diversity Act, 2002

Major Features of the 3rd National Wildlife Action Plan (2017–2031)

India's third National Wildlife Action Plan (NWAP) is the first to align wildlife conservation with **climate change concerns**, ecosystem services, and **landscape-based conservation**.

- **Landscape Approach**: Moves beyond Protected Areas (PAs) to include conservation outside forests, in urban, agricultural, and corridor ecosystems.
- **Mainstreaming Climate Resilience**: First NWAP globally to incorporate **climate adaptation and mitigation**.
- **People-centric Conservation**: Emphasizes community participation, traditional knowledge, eco-tourism, and conflict mitigation.
- **Integration with Development Planning**: Suggests integration of wildlife concerns into **infrastructure and land use policies**, EIA, and local governance.
- **Focus on Marine Biodiversity**: Gives priority to **coastal and marine ecosystems** for the first time.

Positives and Issues of National Wildlife Action Plan (2017–2031)

Positives	**Issues in News/Implementation**
First wildlife plan in India to address **climate change**	Non-binding in nature—**lack of legal enforceability**
Promotes **landscape-level and corridor conservation**	Poor inter-departmental coordination at **state and district level**
Emphasizes **co-management with communities** and indigenous groups	Human-wildlife conflict mitigation efforts remain **fragmented and reactive**
Incorporates **urban biodiversity** and species outside PAs	Inadequate funding and manpower for **monitoring actions**

Student Notes:

Way Forward

- **Legally Anchor NWAP Objectives**: Incorporate key NWAP actions into binding legislations like WPA or EIA Notification.
- **Strengthen Institutional Synergy**: Better coordination between MoEFCC, NHAI, Railways, Tourism, and Water Resources Ministries.
- **Monitoring and Evaluation Framework**: Annual review system with performance indicators at central and state levels.
- **Prioritize Human-Wildlife Conflict Hotspots**: Dedicated budget and fast-response teams in conflict-prone regions.

1.4.3. Environment (Protection) Act, 1986

Major Features

- **Central umbrella legislation** empowering the Union Government to frame rules for **environmental protection, pollution monitoring, and emergency response**.
- Covers key areas: **air, water, noise, hazardous waste, accidents, EIA, coastal zones** and more.
- Enforces **penalties (up to ₹15 lakh)** for violations and daily fines for ongoing non-compliance (Section 15, post-Jan Vishwas Amendment).
- Authorizes **CPCB/SPCBs** to conduct inspections, issue directions, and **initiate legal action**.
- Enables the protection of public health and ecosystems by empowering the Centre to **issue environmental standards/regulations**.

Positives vs Issues

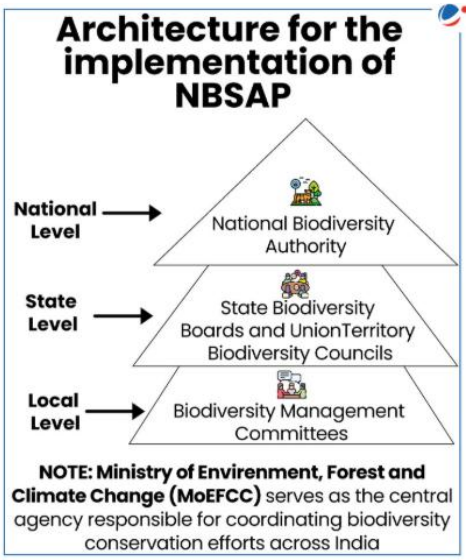
Positives	Issues / Concerns in News
Establishes a **unified national framework** for environmental governance.	Supreme Court deems the Act "toothless" post-amendments—criminal provisions dropped, enforcement stalled.
Enables **proactive NGT intervention** based on media reports.	Ongoing environmental harms: polluted Futala Lake (Nagpur), palm tree felling in Bihar leading to lightning deaths.
Supreme Court struck down **ex-post facto ECs**, reinforcing **precautionary principle**.	Retrofitting EIA unconstitutional—but challenges remain in **implementing refusals**.
Draft **Amendment Rules 2024** lay out consistent adjudication process & central fund.	Persistent issues: illegal quarrying in Kerala forests, oil spill near Kochi, heavy metal air pollution in Delhi.
Enables swift NGT action (e.g., Howrah dumping ground).	Delay in setting mechanisms (SEIAA expired in Delhi), complicating EIA and clearance processes.

Way Forward

- **Operationalize Adjudication**
  - Urgently notify rules and appoint **adjudicating officers** under Section 15C; finalize the **Environment Protection Fund** framework.
- **Enhance Enforcement and Monitoring**
  - Implement real-time remote sensing, **CPCB heavy metal benchmarks**, and uniform inspection across states.
- **Reinforce EIA Safeguards**
  - Ban retrospective ECs fully; operationalize **state-level SEIAA/EAC bodies**, with Delhi reforms.

Student Notes:

- **Strengthen NGT/NGO Participation**
  - Promote **media-based suo motu actions**; scale up civic reporting mechanisms and include environmental impact in public hearings.
- **Target High-Risk Projects**
  - Assess and regulate issues like palm felling in Bihar, quarrying in eco-sensitive zones, oil transport in coastal waters, and dumpsite management.



1.4.4. Biological Diversity Act, 2002

Major Features

- Enacted to conserve biological diversity, ensure sustainable use of its components, and share benefits equitably among local communities.
- Establishes governance architecture: **National Biodiversity Authority (NBA)**, **State Biodiversity Boards (SBBs)**, and **Biodiversity Management Committees (BMCs)**
- Mandates creation of **People's Biodiversity Registers (PBRs)** and empowers these institutions to regulate access to biological resources and traditional knowledge.
- Defines **Access & Benefit-Sharing (ABS)** mechanisms; stipulates approvals for research, commercial use, or patents involving Indian biodiversity.

Positives vs Issues

Positives	Issues
Nationwide institutional framework with NBA, 28 SBBs, ~1.4 lakh BMCs for grassroots biodiversity governance.	**Recent amendments (2023)** decriminalised offences, exempted AYUSH practitioners and codified traditional knowledge from ABS obligations—raising concerns about biopiracy and loss of tribal benefits.
2025 ABS Regulations introduced a tiered benefit-sharing model (0.2–0.6%) and high-value resource fees (≥5%). Expanded scope to include Digital Sequence Information (DSI).	The revised ABS Regulations reduced direct benefit share to 85–90%, and allowed NBA/SBBs to retain funds if resource providers are unidentified—raising equity concerns.
Heritage protection: Biodiversity Heritage Sites designated (e.g., Punjab's Kaya Kalp Vriksh, Gujarat's mangroves).	**Local community disenfranchisement**: AYUSH exemptions diminish tribal rights; ASA compliance is poorly monitored and benefit pools low (<2 % of potential).
NGT's active use: Nayar River case (June 2025) includes Biodiversity Act violations for ecological damage from water projects.	**Weak enforcement**: Nagoya Protocol implementation faltering, lack of public consultation on amendments and regulations.

Student Notes:

Biological Diversity (Amendment) Act, 2023

The **Biological Diversity (Amendment) Act, 2023** updates India's biodiversity framework to align with the Nagoya Protocol, simplify processes, encourage research, and promote traditional medicine and biotech growth.

Major Amendments:

- **Revised definition of biological resources**: Expanded to include "derivatives" (naturally occurring biochemical compounds), replacing "by-products," while still **excluding value-added products**
- **Access & IPR framework**: Indian entities must **register with NBA** before research-based patents; **foreign-controlled companies** require prior NBA approval for access and IPR.
- **Expanded exemptions**: Now includes **codified traditional knowledge**, **cultivated medicinal plants**, and **registered AYUSH practitioners**, easing compliance for domestic users.
- **Decriminalization & penalty revision**: Shift from imprisonment to **financial penalties**, introduction of adjudicating officers, and allowing **anyone to file complaints**.
- **Clarified roles of NBA & SBB**: Empowered State Biodiversity Boards to collect fees and oversee access benefit-sharing (ABS), while the National Authority regulates foreign resource access.

Way Forward

- **Reinstate strong legal deterrents**
  - Recriminalise biodiversity offences involving biopiracy or unauthorized usage.
  - Ensure AYUSH and TK exemptions do not undercut ABS fairness.
- **Improve ABS fairness & reach**
  - Mandate direct benefit transfers to resource-communities; rediscover missing funds.
  - Enhance transparency—public consultations before amending regulations.
- **Empower local governance**
  - Strengthen BMCs in PBR documentation, enforcement, and linkages with tribal communities.
- **Ensure regulatory oversight**
  - Formal approvals for patents/IPR to be mandatory, not just notifications.
  - Audit NBA and SBBs regularly to ensure ABS funds are utilized properly.
- **Capacity-building & awareness**
  - Train BMCs/SBBs in ABS management, biospecimen tracking, and DSI monitoring.
  - Educate traditional knowledge holders about their rights and benefit-sharing mechanisms.

1.4.5. Indian Forest Act, 1927

Major Features

- Defines and classifies forests into **Reserved, Protected, Village, and Private Forests**.
- Grants government strict **control over forests, wildlife, and grazing**; permits are needed for entry, felling, or grazing.
- Criminalizes **illegal logging, grazing, and encroachment** with punishments including imprisonment and fines.
- Empowers **forest officers** to enforce rules, seize unauthorized property, and conduct prosecutions.
- Religious or traditional use is permitted only via **special exemptions**, rarely granted.

Student Notes:

Positives vs Issues

Positives	Issues
Offers clear **classification** and strong legal authority to prevent encroachment.	Over 10,000 acres recently encroached in Odisha's Reserved Forests amid enforcement lapses.
Supports **penal measures** and empowers officers to conduct seizures, deterring illegal activity.	Tribals and Adivasis often arrested for gathering forest produce—displaced under FRA but still criminalized.
Creates a structured basis for **forest administration and surveillance**.	Lack of judicial oversight on officer actions; recurring charges of forest officer misconduct.
Serves as the primary legal framework for forest protection.	Does not align with Forest Rights Act 2006; conflicting provisions create confusion on rights and restrictions.

Case Study: Removal of Bamboo from Indian Forest Act, 1927 – Decentralizing Green Wealth

Until 2017, **bamboo was classified as a "tree"** under the **Indian Forest Act (IFA), 1927**, which meant that even **felled bamboo from non-forest areas required permissions** for felling, transport, and sale. This restricted local communities—especially tribals from benefiting economically, despite bamboo being abundant in tribal regions.

Implications:

Positive Outcomes	Concerns Raised
• **Livelihood boost** for tribal and rural communities. • Expansion of India's **bamboo-based industries** (furniture, paper, bioenergy). • **Support for carbon sequestration** through faster-growing bamboo plantations.	• Environmentalists feared **unregulated harvesting** in absence of local monitoring. • States with strong forest departments (like Mizoram, Chhattisgarh) resisted, fearing **loss of control over forest produce**. • Lack of proper market linkages and MSP-like mechanisms meant **economic gains remained uneven**.

Way Forward

- **Harmonize with Forest Rights Act 2006**, recognizing community rights in village forests.
- **Improve enforcement accountability** with judicial review of seizures and prosecutions.
- **Strengthen forest officer training** in human rights, community liaison, and FRA compliance.
- **Empower Gram Sabhas** in Protected and Village Forests—shift from top-down control to inclusion.

1.4.6. Forest (Conservation) Act, 1980

Major Features

- Requires **central government approval** for diversion of any forest land for non-forestry purposes.

Student Notes:

- Defines "forest land" broadly, using any government notification—even if not formally classified.
- Mandates **compensatory afforestation**, wildlife clearance, and catchment area protection.
- Obligates **recognition and recording of rights** of Scheduled Tribes and other forest dwellers under the FRA, where applicable.
- Enforced via the **Ministry of Environment, Forest and Climate Change (MoEFCC)** with oversight from the Gram Sabha/State government.

Positives vs Issues

Positives	**Issues/News**
Prevents indiscriminate forest land use by regulating diversion centrally.	Notification amendments limit FRA certifying authority in Tamil Nadu—tribals fear loss of entitlements.
Institutionalized compensatory afforestation transfer.	Comp afforestation often on degraded lands with poor survival rates
Introduced **non-forest penalty** concept—states must secure approval before non-forest use.	Centre penalized for non-compliance (e.g. in Uttarakhand, Maharashtra); penalties remain uncollected.
Includes FRA, strengthening rights recognition in diverted forest land processes.	Discrepancies in Gram Sabha consultations reveal FRA implementation to be uneven.
Encourages integrated land-use planning through compensatory plantations.	"Net loss" mitigation claims face scrutiny; audit reveals inflated figures to Mobar dam project.

Forest (Conservation) Amendment Act, 2023

The **Forest (Conservation) Amendment Act, 2023** redefines forest governance by clarifying the scope of forest land, introducing exemptions, and enhancing central oversight.

Key Highlights:

- **Forest land** now includes only areas recorded as forest on or after **Oct 25, 1980**, unless diverted by **Dec 12, 1996**.
- **Exemptions** from prior approval for strategic projects near borders, roads/railways (up to 0.10 ha), LWE areas (up to 5 ha), and security infrastructure (up to 10 ha).
- **New permissible activities**: Eco-tourism, safaris, silviculture, and surveys.
- **Central authority** strengthened with power to issue directions for Act implementation.

Case Study: Gachibowli Biodiversity Area – Balancing Urban Growth and Ecological Concerns

Gachibowli in Hyderabad, part of the rapidly expanding IT corridor, has seen intense real estate and infrastructure growth, often at the expense of ecologically sensitive zones. The area lies near the **KBR National Park Eco-Sensitive Zone (ESZ)** and the **Biodiversity Park**, both critical urban green lungs.

Issue:

Multiple infrastructure projects (e.g., **flyovers under SRDP**, luxury housing) were approved with **questionable Environmental Clearances**. Citizens and environmental groups alleged:

- Violation of **ESZ norms**,
- Felling of hundreds of trees without proper assessment,

Student Notes:

- Lack of public consultation.

Supreme Court Intervention (2024):

The Court emphasized that **"urban convenience cannot override ecological sanctity"**, reinforcing the need for **proper EIA procedures** and **public consultation**.

Way Forward

- **Ensure true Gram Sabha consultation** during Stage I & II of forest diversion clearances.
- **Match compensatory afforestation standards** with the natural forest—emphasize native species, ecological value.
- **Enforce penalty collection** when states violate approvals.
- **Conduct periodic audits** on forest diversion and afforestation; make data publicly accessible.
- **Define and use net benefit standards**, not just compensatory acreage.

1.4.7. National Forest Policy, 1988

- Declares sustainable **"maintaining environmental stability"** with minimum 33% forest cover.
- Recognizes **rights of tribal communities**, supports Joint Forest Management.
- Promotes **conservation**, afforestation of wastelands, and **regulation of grazing**.
- Emphasizes the role of forests in **fuel, fodder, livelihoods** and ecological services.

Why We Need a New Forest Policy?

- **Decadal changes**: climate stress, deforestation, biodiversity loss unmet by 1988 goals.
- **Modern challenges**: carbon sequestration imperatives (Paris Agreement), REDD+ mechanisms, ecosystem restoration.
- **Community inclusion**: 1988 policy is outdated on indigenous rights and participatory management (post-FRA 2006).
- **Urban and fringe forests**: need recognition in fast-growing cities to mitigate heat and pollution.
- **Scientific advancements**: satellite monitoring, canopy-free forest metrics, and climate-resilient species need new policy grounding.
- **Private sector role**: carbon markets, biodiversity offsets, and CSR forestry demand a fresh legal-institutional policy framework.

1.4.8. Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

(Commonly known as the Forest Rights Act or FRA, 2006)

Major Features

- Recognizes **historical injustices** done to forest-dwelling communities.
- Grants legal **individual forest rights (IFR)** to Scheduled Tribes (STs) and **Other Traditional Forest Dwellers (OTFDs)**.
- Recognizes **community forest rights (CFRs)** for collective use of forest land and resources.
- Empowers **Gram Sabhas** to initiate claims, verify records, and manage minor forest produce.
- Promotes **sustainable use** and conservation by community-led governance systems.
- Overrides conflicting provisions in earlier forest laws, including the **Indian Forest Act, 1927**.

Positives vs Issues

Positives of FRA, 2006	Issues Highlighted in News / Reports
Restores dignity and ownership rights of Adivasi and forest communities.	**CFR claims pending** in 65% of eligible villages (MoTA 2025 report).

Student Notes:

Empowers **Gram Sabhas** as the statutory authority for land verification and resource use.	States like Madhya Pradesh and Odisha continue to **bypass Gram Sabha** during forest diversion clearances.
Recognizes **community resource use**, vital for livelihoods and food security.	Commercial plantation projects (e.g. oil palm in NE India) are being approved without community consent.
Supports traditional **eco-friendly lifestyles**, aligned with conservation.	**Legal evictions** rise after denial of claims—over 20,000 families affected in Telangana and Chhattisgarh (2024–25).
Reinforces participatory forest management.	Lack of **legal literacy**, mapping support, and land records delay the process.

Case Study: Mendha Lekha Village, Gadchiroli (Maharashtra)

- First village in India to **successfully claim CFR** under FRA.
- Manages over **1,800 hectares of forest** through the Gram Sabha.
- Earns **revenue from bamboo**, tendu, and forest produce—fully managed by the community.
- Demonstrated successful forest regeneration and **zero deforestation**, while improving livelihoods.

FRA and Recent Developments

- **Budget 2025-26**: Announced ₹1,200 crore for "FRA Implementation Strengthening Mission".
- **Supreme Court** (April 2025): Directed states to **not evict forest dwellers with pending claims**.
- **MoTA Report** (May 2025): Only **19% of CFR claims fully settled**, highlights need for urgent reforms.
- **Palm Oil Plantation Row** (Assam, 2024–25): Gram Sabha consent bypassed; FRA provisions ignored—triggered protest.

Way Forward

- **Digitize claim processes** and provide support to Gram Sabhas via trained facilitators and NGOs.
- Mandate **prior informed consent** for forest diversion under FRA Section 5—enforceable by MoEFCC.
- Increase capacity building for **state nodal officers**, forest officials, and tribal development departments.
- Institutionalize **convergence with MGNREGA**, Jal Jeevan Mission, etc. for CFR development plans.
- Track implementation via **real-time dashboards** on CFR, IFR, and claim status.

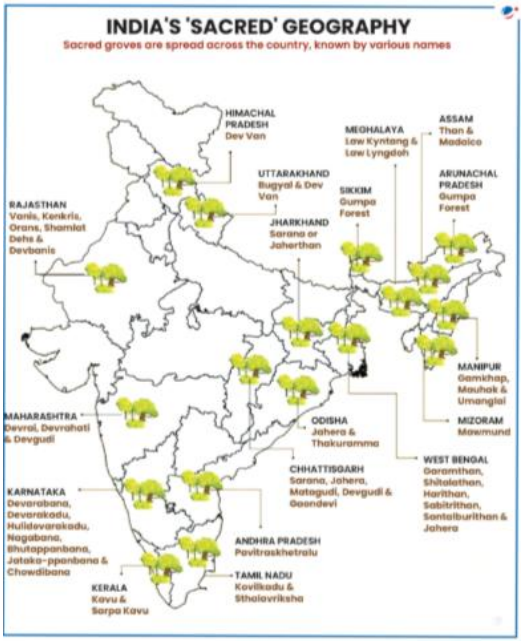
1.4.9. Sacred Groves of India

Traditional socio-ecological conservation systems protecting biodiversity through cultural and religious practices.

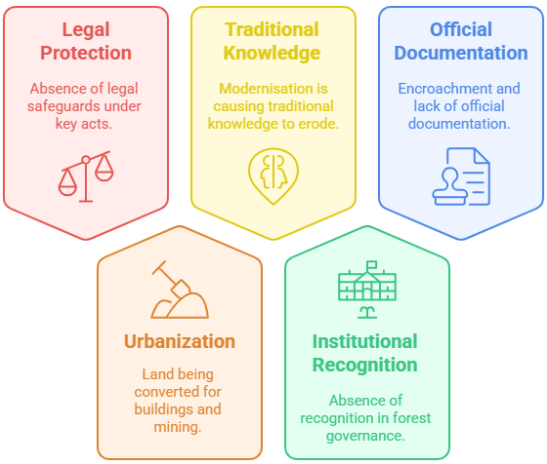
Major Features

- **Definition**: Sacred groves are patches of forest or natural vegetation preserved by local communities due to religious and spiritual beliefs, often dedicated to deities, spirits, or ancestors.
- **Traditional Custodians**: Maintained by **tribal and rural communities**, especially in states like Maharashtra, Kerala, Himachal Pradesh, Meghalaya, Odisha, and Rajasthan.

- **No Human Disturbance**: Entry, cutting trees, hunting, or extracting resources is traditionally prohibited or strictly regulated.
- **Ecological Significance**:
  - Act as **micro biodiversity hotspots**.
  - Preserve **endemic, medicinal, and rare species** of flora and fauna.
  - Serve as **gene banks**, important for climate adaptation.
- **Cultural Significance**:
  - Sites of religious festivals, folk traditions, oral histories.
  - Represent **community-led conservation ethos** without formal state protection.



Sacred Grove Concerns



Recent Developments

- **MoEFCC (2025)** initiated discussions to include *"Sacred Groves" under community reserves* for enhanced legal protection via amendments to the **Wildlife Protection Act**.
- **Kerala Biodiversity Board** in April 2025 launched a digitization drive to map 1,200+ groves using **GIS and drone surveys**.
- **Tribal Ministry's push** to integrate sacred groves into **India's carbon sequestration goals**, aligning with Nationally Determined Contributions (NDCs).
- **UNESCO recognition** (March 2025): India's **sacred groves network nominated as "Traditional Conservation Landscape"** under the cultural-ecological heritage category.

Way Forward

- **Legal Recognition**: Sacred groves should be notified under the Wildlife Protection Act (as "Community Reserves") or Biodiversity Act.
- **Mapping and Documentation**: Digitize and record groves via the State Biodiversity Boards in the People's Biodiversity Registers (PBRs).
- **Integration with LiFE Mission**: Promote sacred grove conservation under India's lifestyle for environment (LiFE) initiative for behavioral change.
- **Eco-Tourism and Education**: Encourage **eco-cultural tourism** around sacred groves with safeguards, and include their study in school curricula.
- **Incentivize Gram Sabhas**: Provide monetary and policy incentives to **Gram Sabhas** and community custodians for protection and awareness drives.

"In an age of climate crises, Sacred Groves are not relics of the past—but blueprints for the future."

Student Notes:

Student Notes:

1.4.10. International Conventions for biodiversity conservation

Convention	Overview	Importance
CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)	**CITES** is an international agreement signed in 1973 aimed at ensuring that international trade in wild animals and plants does not threaten their survival.	CITES has played a crucial role in protecting species like elephants, rhinos, tigers, and pangolins from illegal poaching and trade.
CMS (Convention on the Conservation of Migratory Species of Wild Animals)	The **CMS**, or the **Bonn Convention**, was adopted in **1979** and aims to conserve migratory species across their entire range. It focuses on species that migrate across borders, either globally or within regions.	The **CMS** provides legal and technical frameworks for the conservation of migratory species like **bats**, **whales**, **birds**, and **sea turtles**. It encourages countries to adopt measures for protecting these species across their migratory routes.
UN CBD (United Nations Convention on Biological Diversity)	The **CBD** is an international treaty adopted in **1992** at the **Earth Summit** in Rio de Janeiro. It aims to conserve **biodiversity**, ensure the sustainable use of **biological resources**.	It provides the framework for national strategies and action plans to protect biodiversity and establish policies like **Access and Benefit Sharing (ABS)** and **Protected Areas**.
PGRFA (Plant Genetic Resources for Food and Agriculture)	**PGRFA** refers to the genetic material of plants that are used for food and agriculture, including those that are important for **food security, crop improvement, and maintaining agricultural biodiversity**.	**PGRFA** is critical for ensuring food security, as it supports the breeding of new crop varieties, which helps to increase yields and adapt to pests, diseases, and climate change.
Man and Biosphere Programme (MAB programme)	The **Man and Biosphere (MAB) Programme**, launched in **1971** by the **UNESCO**, aims to promote sustainable development by fostering a balanced relationship between humans and the environment.	The MAB Programme is crucial for promoting **sustainable land use** and **ecosystem management** through the establishment of **Biosphere Reserves**. These reserves serve as model areas for **biodiversity conservation**, research, and community involvement.

1.4.11. Kunming-Montreal Global Biodiversity Framework

The **Kunming-Montreal Global Biodiversity Framework** was adopted at the **15th Conference of the Parties (COP15)** to the **Convention on Biological Diversity (CBD)**, held in **Montreal** in **December 2022**.

The framework integrates **ecosystem conservation**, **sustainable use**, **financial support**, and **equity** considerations while building upon the **Aichi Targets** and the lessons learned from the past decade.

Student Notes:

Key features of the Kunming-Montreal Global Biodiversity Framework

- **Action-Oriented Global Targets:** The framework sets 23 action targets for 2030, focusing on reducing threats to biodiversity, enhancing sustainable use, and improving the overall health of ecosystems.
- **Target 30x30**: One of the most prominent features is the target to protect 30% of land and marine areas by 2030.
- **Restoration and Ecosystem Services:** The framework aims to restore 30% of degraded ecosystems by 2030.
- **Finance and Resource Mobilization:** The framework calls for the mobilization of $200 billion per year from all sources, including public, private, and international finance, to support biodiversity conservation efforts.
- **Nature-Based Solutions:** The framework promotes nature-based solutions to address climate change and biodiversity loss, encouraging actions such as ecosystem restoration.

Mission LIFE

Launched at COP27 summit, aims to encourage sustainable living and promote environment-friendly practices among individuals, communities, and organizations.

As a global programme, Mission LiFE envisions three core shifts in our collective approach towards sustainability

- **Change in Demand (Phase I):** Nudging individuals across the world to practice simple yet effective environment-friendly actions in their daily lives.
- **Change in Supply (Phase II):** Changes in large-scale individual demand are expected to gradually nudge industries and markets to respond and tailor supply and procurement as per the revised demands.
- **Change in Policy (Phase III):** By influencing the demand and supply dynamics of India and the world, the long-term vision of Mission LiFE is to trigger shifts in large-scale industrial and government policies that can support both sustainable consumption and production.

Student Notes:

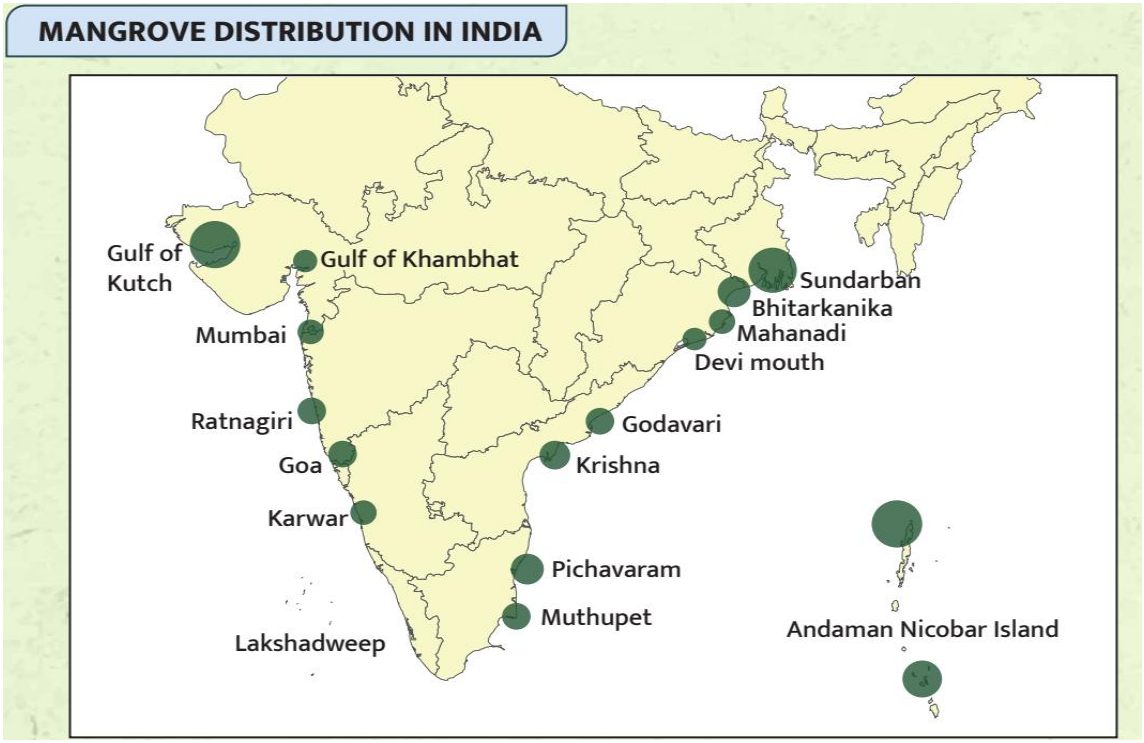
1.5. Coastal conservation

Coastal areas represent dynamic interfaces where land meets sea, harboring unique ecosystems and supporting immense biodiversity. They provide crucial ecosystem services, protect inland areas from extreme weather, and form the economic backbone for millions, particularly in India with its vast coastline.

However, these vital zones face escalating threats from pollution, climate change, and unsustainable anthropogenic activities, necessitating a robust framework for their conservation and sustainable management.

1.5.1. Mangroves

Mangroves are unique salt-tolerant evergreen forests found in tropical and subtropical intertidal zones. They serve as critical ecological buffers, protecting coastlines from erosion, storm surges, and tsunamis.

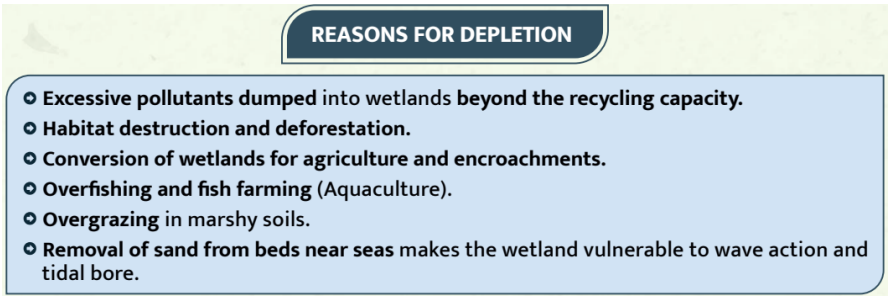


Student Notes:

- **Indian Government Programs:**
  - **Mangroves for the Future (MFF):** A partnership-based initiative to promote investment in coastal ecosystems, including mangroves.
  - **MISHTI (Mangrove Initiative for Shoreline Habitats & Tangible Incomes):** A recent (Budget 2023-24) initiative to promote mangrove plantation along the coastline and on salt pan lands, emphasizing livelihood benefits.
  - **CAMPA (Compensatory Afforestation Fund Management and Planning Authority):** Funds can be utilized for mangrove afforestation as part of compensatory measures.

1.5.2. Wetlands

Wetlands are transitional areas between terrestrial and aquatic systems, including marshes, swamps, bogs, and lakes. They are among the most productive ecosystems globally, providing crucial services like **water purification, flood control, groundwater recharge, and supporting immense biodiversity** (especially migratory birds).



- **Indian Government Programs to Cover:**
  - **Ramsar Convention on Wetlands:** India's participation and commitment to identifying and conserving Wetlands of International Importance (Ramsar Sites) under this global convention.
  - **National Wetland Conservation Programme (NWCP):** India's dedicated program for conservation and wise use of wetlands.
  - **Amrit Dharohar Initiative:** A recent (Budget 2023-24) scheme promoting the unique conservation values of Ramsar Sites through local community participation.

1.5.3. Blue Economy

The 'Blue Economy' refers to the sustainable use of ocean resources for economic growth, improved livelihoods, and ocean ecosystem health. Given India's vast coastline and maritime interests, it holds immense potential for sustainable development.

- **Components of Blue Economy:** It encompasses traditional sectors like fisheries, aquaculture, shipping, and marine tourism, alongside emerging areas like renewable ocean energy (e.g., offshore wind), marine biotechnology, and sustainable deep-sea resource exploration.

Significance of the Blue Economy for India

- **Economic Prosperity**: The Blue Economy is a vital contributor to India's growth, opening up new avenues for trade, jobs, and innovation across sectors like tourism, shipping, and renewable energy.
- **Sustainability and Environmental Management**: By integrating sustainable practices, the Blue Economy framework helps reduce the ecological footprint of industries like fishing and tourism, fostering a balance between economic development and environmental protection.
- **Inclusivity and Livelihoods**: The sector supports millions of coastal communities and offers opportunities for inclusive growth, providing sustainable livelihoods for vulnerable groups, especially in fishing and marine-based sectors.
- **Global Competitiveness**: India's maritime capabilities position it as a leader in global trade, with its strategic maritime initiatives contributing to **trade, security**, and **international cooperation** in maritime activities.

Student Notes:

Indian Government Programs

- **India's Blue Economy Policy Framework:** Outlines the vision and strategy for sustainable utilization of marine resources.
- **Deep Ocean Mission:** Aims for exploration of deep ocean resources, marine biodiversity, and energy, with an emphasis on sustainable practices.
- **Fisheries Sector Reforms:** Promoting sustainable fishing practices, discouraging destructive methods, and enhancing livelihoods of coastal communities in an environmentally sound manner.

Coastal Sand Mining: A Destructive Practice

Coastal sand, vital for construction, is often extracted unsustainably from beaches and seabeds. While providing raw materials, unchecked sand mining leads to severe environmental degradation.

Impact of coastal sand mining

Coastal sand mining, both legal and illegal, profoundly impacts India's coastline, with severe environmental and socio-economic consequences:

- **Exacerbated Coastal Erosion:** Removal of sand destabilizes beaches and dunes, making coastlines more vulnerable to erosion by waves and currents.
- **Increased Saline Intrusion:** Depletion of coastal sand barriers leads to saltwater infiltrating freshwater aquifers, contaminating drinking water sources and agricultural lands.
- **Destruction of Coastal Habitats:** Mining directly destroys critical marine ecosystems, including nesting sites for sea turtles (e.g., along **Odisha's coast** for Olive Ridley turtles).
- **Disruption of Livelihoods:** Coastal communities, particularly fishermen, suffer from reduced fish catches due to habitat destruction and degradation of breeding grounds.

Indian Government Programs/Regulatory Aspects to Cover:

- **Coastal Regulation Zone (CRZ) Notifications:** These notifications (e.g., CRZ 2011, CRZ 2018) regulate activities in coastal areas, including strict prohibitions or regulations on sand mining.
- **Legal & Illegal Dimensions:** Discussion on the challenges of enforcing regulations, the prevalence of illegal sand mining, and its nexus with powerful lobbies.
- **Role of Judiciary:** Intervention by the National Green Tribunal (NGT) and Supreme Court in directing states to curb illegal sand mining.

2. ENVIRONMENTAL POLLUTION AND DEGRADATION

Student Notes:

Previous Year Questions (PYQ's)

1. Industrial pollution of river water is a significant environmental issue in India. Discuss the various mitigation measures to deal with this problem and also the government's initiatives in this regard. (2024)
2. What is oil pollution? What are its impacts on the marine ecosystem? In what way is oil pollution particularly harmful for a country like India?(2023)
3. Discuss in detail the photochemical smog emphasizing its formation, effects and mitigation. Explain the 1999 Gothenburg protocol. (2022)
4. Describe the key points of the revised Global Air Quality Guidelines (AQGs) recently released by the World Health Organisation (WHO). How are these different from its last update in 2005? What changes in India's National Clean Air Programme are required to achieve these revised standards? (2021)
5. What are the key features of the National Clean Air Programme (NCAP) initiated by the Government of India? (2020)
6. What are the impediments disposing the huge quantities of discarded solid waste which are continuously being generated? How do we remove safely the toxic wastes that have been accumulated in our habitable environment? (2018)
7. Discuss the Namami Gange and National Mission for Clean Ganga (NMCG) programmes and causes of mixed results from the previous schemes. What quantum leaps can help preserve the river Ganga better than incremental inputs? (2015)
8. Enumerate the National Water Policy of India. Taking river Ganges as an example, discuss the strategies which may be adopted for river water pollution control and management. What are the legal provisions of management and handling of hazardous wastes in India? (2013)
9. What are the consequences of Illegal mining? Discuss the Ministry of Environment and Forests' concept of GO AND NO GO zones for coal mining sector. (2013)

PYQs Analysis

UPSC questions in this section explore **pollution sources, health/ecosystem impacts, regulatory gaps, and governance challenges**, often tying in global norms with India-specific actions.

- **Air & Water Pollution Management:** Repeated focus on river pollution (2024, 2015, 2013) and urban air quality (2021, 2020, 2022) shows concern for critical resources. UPSC expects knowledge of schemes like **NCAP, NMCG**, and alignment with global standards like **WHO AQGs** and **Gothenburg Protocol**.
- **Pollution Types & Impacts:** Questions on **oil pollution** (2023), **photochemical smog** (2022), and **toxic waste** (2018) reflect thematic variety and demand understanding of **pollution-specific effects on human health, biodiversity**, and national vulnerabilities.
- **Governance, Laws & Mining-Linked Degradation:** Older questions (2013) address **hazardous waste rules**, **illegal mining**, and **Go/No-Go zones**, showing UPSC's interest in regulatory frameworks and the environmental costs of extractive industries.

2.1. Pollution

Pollution is defined as 'an addition or excessive addition of certain materials to the physical environment (water, air, and lands), making it less fit or unfit for life'. It represents a critical threat to human health, ecosystems, and sustainable development.

2.1.1. Understanding Pollutants

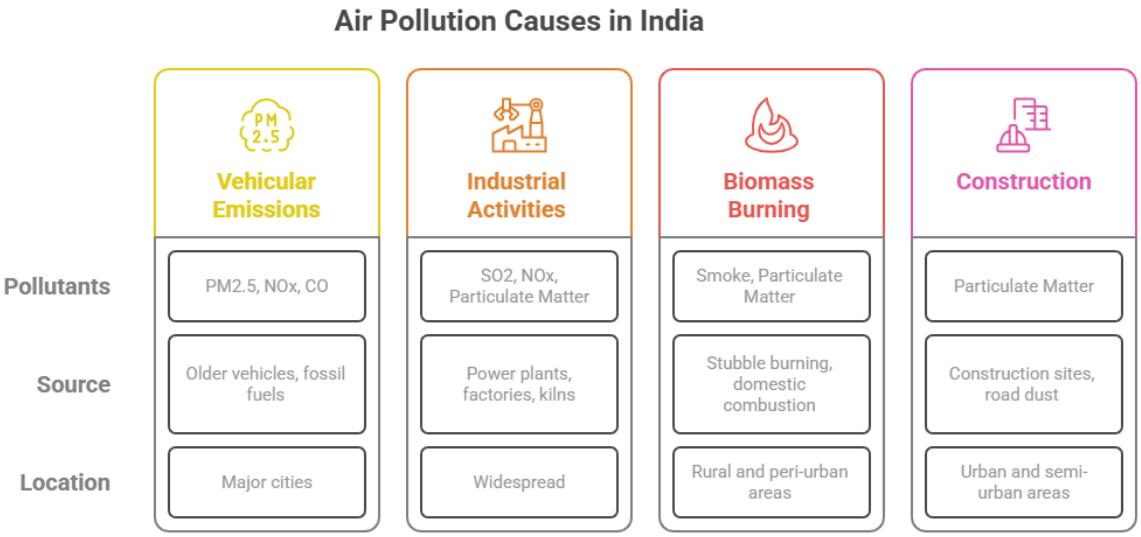
Pollutants can be classified based on various characteristics:

Student Notes:

- **According to Form After Release:**
  - **Primary Pollutants:** These persist in the form in which they are added directly to the environment (e.g., DDT, plastic).
  - **Secondary Pollutants:** These are formed by the interaction among **primary pollutants** (e.g., Peroxyacetyl Nitrate - PAN, formed from nitrogen oxides and hydrocarbons).
- **According to Existence in Nature:**
  - **Quantitative Pollutants:** Occur naturally but become pollutants when their concentration exceeds a threshold level (e.g., carbon dioxide, nitrogen oxide).
  - **Qualitative Pollutants:** These are man-made substances that do not occur in nature (e.g., fungicides, herbicides, DDT).
- **According to Nature of Disposal:**
  - **Biodegradable Pollutants:** Waste products that can be degraded by microbial action (e.g., sewage).
  - **Non-biodegradable Pollutants:** Pollutants that are not decomposed by microbial action (e.g., plastics, glass, DDT, heavy metal salts, radioactive substances).

2.2. Air Pollution

Air pollution remains one of India's most pressing environmental and public health challenges. It refers to the presence of harmful substances in the atmosphere, leading to adverse effects on human health, climate, and ecosystems.



The air pollution in Delhi differs from that of Mumbai

Factor	Delhi	Mumbai
Dominant Sources	Vehicular emissions, industrial activity, **stubble burning**	Vehicles, industries, construction dust, coastal industrial clusters
Meteorological Impact	Temperature inversions, low wind speeds, severe smog in winter	Strong sea breezes aiding pollutant dispersion throughout the year
Topography & Dispersion	Indo-Gangetic Plain, **"bowl effect,"** poor ventilation	**Coastal location,** better atmospheric exchange towards the sea
Type of Smog	Photochemical smog mixed with particulate haze, especially in winter	Less intense smog, different concentrations due to coastal conditions

What is the **economic cost of air pollution?**

- **Public Health Costs:** Air pollution is a significant public health issue in India. The World Health Organization (WHO) estimates that air pollution is linked to approximately 7 million deaths worldwide every year.

Student Notes:

- **Economic Impact on Businesses:** Air pollution also affects businesses in India. A report by Dalberg Advisors found that air pollution costs Indian businesses about USD 95 billion every year, around 3% of India's total GDP.
- **Impact on Tourism:** The tourism industry in India is also affected by air pollution. A report by the **World Economic Forum** highlights that air pollution in India costs the Indian economy $95 billion per year, and investment in cleantech is needed to save lives and improve economic prospects.

The economic burden of air pollution in India is multifaceted, affecting **public health, business productivity, tourism, and regional economies**. Addressing this issue requires comprehensive policies and investments in clean technologies to mitigate the adverse effects of air pollution.

Initiatives Taken by India to Tackle Air Pollution

India has implemented a multi-pronged approach to combat air pollution:

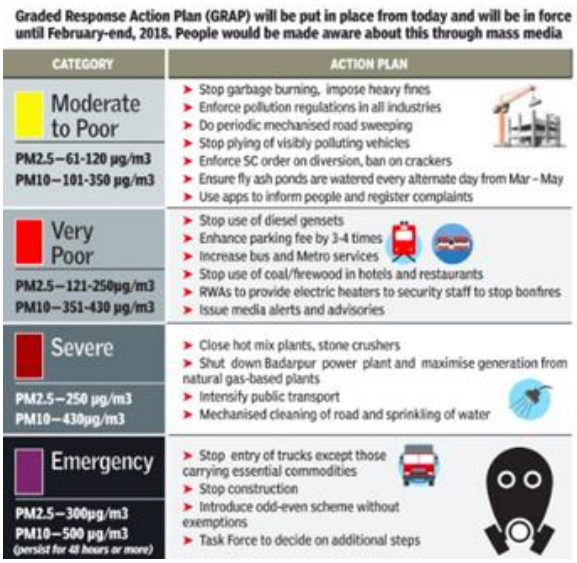
- **Strict Emission Norms:** Phased implementation of Bharat Stage (BS) emission standards for vehicles, moving towards BS-VI.

How transitioning to cleaner fuels (e.g., natural gas for industries, electric vehicles, green hydrogen) acts as a dual strategy for air quality improvement and decarbonization?

Transitioning to cleaner fuels acts as a dual strategy for **air quality improvement and decarbonization** through these key mechanisms:

- **Reduced Criteria Pollutants:** Cleaner fuels, like natural gas, produce significantly lower **particulate matter (PM), nitrogen oxides (NOx), and sulfur oxides (SOx)** compared to coal or diesel. Electric vehicles (EVs) eliminate tailpipe emissions entirely, directly improving local air quality.
- **Lower Greenhouse Gas (GHG) Emissions:** Natural gas combustion emits less CO2 than coal or oil for the same energy output. Green hydrogen, produced using renewable electricity, results in near-zero or zero carbon emissions during its entire lifecycle, directly contributing to decarbonization goals.
- **Enhanced Energy Efficiency:** The technologies associated with **cleaner fuels** (e.g., modern natural gas turbines, electric vehicle motors) are often more energy-efficient than traditional counterparts, leading to reduced overall energy demand and associated emissions.

- **Promoting Cleaner Energy:** Initiatives like the **Ujjwala Yojana (LPG connections**) to reduce biomass burning, and rapid expansion of renewable energy capacity to decrease reliance on coal.
- **Graded Response Action Plan (GRAP):** An emergency action plan for Delhi-NCR, based on air quality levels, to restrict polluting activities during severe episodes.
- **National Clean Air Programme (NCAP):** The **National Clean Air Programme (NCAP)**, launched in 2019, is India's first-ever national framework to tackle air pollution. It aims to reduce **particulate matter** (PM2.5 and PM10) concentration by 20-30% by 2024 (now extended to 2026) compared to 2017 levels, in **131 non-attainment cities.**



Student Notes:

- **Legal Frameworks:** Enacting and strengthening environmental laws like the **Air (Prevention and Control of Pollution) Act, 1981.**

Various challenges in real-time data availability and ensuring equitable monitoring across all polluted areas:

- **Technological Gaps & Broken Promises:** Despite efforts, the number of **Continuous Ambient Air Quality Monitoring Stations (CAAQMS)** remains limited, particularly beyond **Tier-1 cities**. Even existing stations frequently face issues with maintenance, calibration, and operational efficiency, leading to data gaps and questions about reliability.
- **The Monitoring Desert:** Air pollution, unfortunately, doesn't adhere to **municipal boundaries**. While major urban centers might have some monitoring, vast swathes of industrial belts, smaller towns, and rural areas remain largely unmonitored. This creates **"data deserts,"** hiding true pollution hotspots.

Why have these initiatives not scaled up effectively to tackle air pollution?

- **Fragmented Governance & Overlapping Mandates:** Numerous agencies are involved across central and state levels, leading to poor coordination and diluted accountability in implementation. This results in a lack of unified strategy and delayed decision-making processes.
- **Inadequate Funding and Resource Allocation:** Financial resources for pollution control are often insufficient and inconsistent, especially for local bodies. The high cost of cleaner technologies also hinders adoption by SMEs and individuals without significant incentives.
- **Insufficient Infrastructure Development:** Essential supporting infrastructure, like adequate public transport networks, EV charging points, and scientific waste management facilities, is still developing. This directly impacts the effectiveness of abatement measures on the ground.
- **Challenges in Regulating the Informal Sector:** A substantial portion of air pollution stems from decentralized and often unorganized economic activities. Integrating and regulating this vast informal sector remains a complex policy and implementation hurdle.

Landmark judgement by Supreme Court and National Green Tribuanl (NGT) in driving the pollution control-

- **M.C. Mehta v. Union of India (Oleum Gas Leak Case, 1986):** Established the principle of **'Absolute Liability'** for hazardous industries, making them fully responsible for environmental harm regardless of negligence. This significantly heightened corporate accountability for pollution.
- **Vellore Citizens' Welfare Forum v. Union of India (1996):** Applied the **'Polluter Pays Principle'** and **'Precautionary Principle'**. Directed polluting industries to compensate for damage and mandated preventive measures.
- **Subhash Kumar v. State of Bihar (1991):** Interpreted **Article 21 (Right to Life)** to include the **right to a pollution-free environment**. This empowered citizens to seek legal redress against pollution.

How curbing air pollution offers co-benefits for climate change mitigation?

Curbing air pollution offers significant co-benefits for climate change mitigation through several interconnected mechanisms:

Student Notes:

- **Reduction of Short-Lived Climate Pollutants (SLCPs):** Many air pollutants are also potent climate-warming agents. Reducing emissions of **Black Carbon (soot)**, **Methane (CH4)**, and **Tropospheric Ozone (O3)** not only improves air quality but also directly reduces global warming.
- **Decreased Greenhouse Gas (GHG) Emissions from Shared Sources:** Measures targeting common sources of air pollution, such as fossil fuel combustion in industries, power generation, and vehicles, simultaneously lead to a reduction in long-lived greenhouse gases like **Carbon Dioxide (CO2)**.
- **Enhanced Carbon Sequestration by Ecosystems:** Air pollution, particularly **acid rain and ground-level ozone,** can damage forests, crops, and other vegetation, impairing their ability to absorb CO2. Cleaner air allows ecosystems to recover, strengthening their capacity to **act as natural carbon sinks and store more carbon**.
- **Promotion of Cleaner Technologies and Energy Efficiency:** Policies and innovations aimed at reducing air pollution often drive the adoption of more **energy-efficient processes and cleaner technologies** (e.g., electric vehicles, advanced industrial filters, renewable energy). These technological shifts inherently lead to lower overall fossil fuel consumption and thus reduced GHG emissions.

2.2.1. Smog

Smog is a type of intense air pollution that reduces visibility and can severely impact health.

Type of Smog	Formation	Characteristics
Classical Smog	Results from combustion of coal/sulfur-containing fuels. Combines **sulfur dioxide (SO2)** with particulate matter and damp air/fog.	Appears as a grayish haze. Occurs in cold, humid winter conditions.
Photochemical Smog	Primary pollutants (**NOx, VOCs**) from vehicular/industrial emissions react in strong **sunlight**. Produces secondary pollutants like ground-level ozone (O3).	Appears as a brownish haze. Prevalent in warm, sunny urban areas with heavy traffic.

International conventions to tackle smog

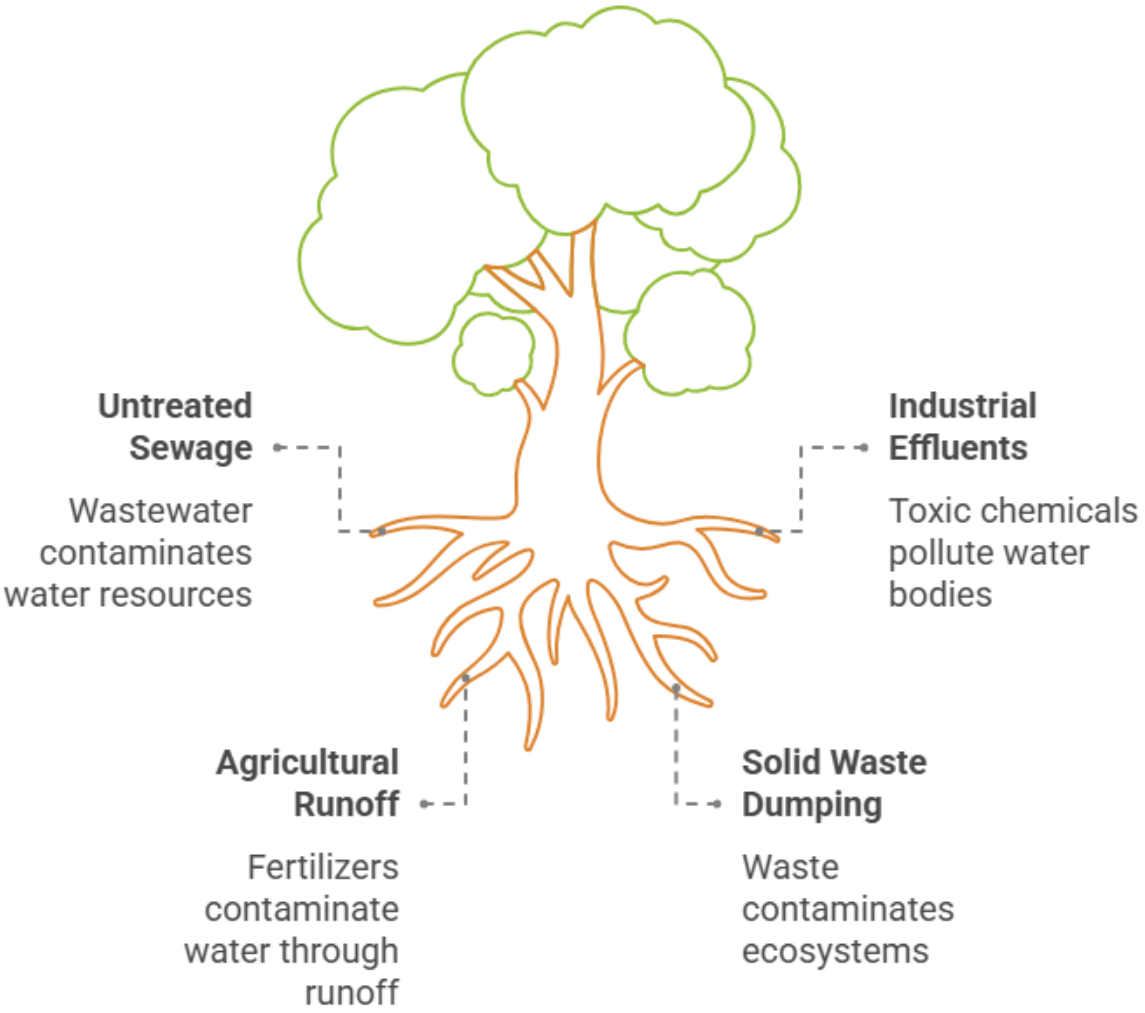
- **Gothenburg Protocol:**
  - An international agreement under the **United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution**.
  - It aims to control and reduce transboundary air pollution by setting emission ceilings for various pollutants like SO2, NOx, VOCs, and Ammonia.
- **WHO Global Air Quality Guidelines:** These guidelines provide **evidence-based targets** for various air pollutants. Though non-binding, they serve as crucial benchmarks for national governments, including India, to formulate and revise their air quality standards and policies.

2.3. Water pollution

Water pollution, the contamination of water bodies, stands as a **critical environmental concern** in India, impacting human health, aquatic ecosystems, and economic activities. It occurs when harmful substances, chemicals, or microorganisms are introduced into water, rendering it unfit for use.

Student Notes:

Causes of Water Pollution in India



Groundwater contamination in India

The problem of groundwater contamination is alarming in India, with contaminants rendering crucial resources unusable across vast regions. This issue is particularly dominant in:

- **Eastern Gangetic Plains:** Characterized by widespread **arsenic contamination**.
- **Arid and Semi-Arid Regions (e.g., Rajasthan, Gujarat):** Prone to **fluoride contamination** and **salinity**.
- **Industrial Clusters:** Experience significant heavy metal and chemical pollution.

Specific Drivers of groundwater Contamination

While numerous factors contribute, specific drivers stand out:

- **Geogenic Contamination:** Naturally occurring geological processes lead to the presence of harmful elements.
  - For instance, **arsenic** contaminates groundwater in alluvial plains, particularly in the Gangetic basin, due to natural geological formations.
- **Industrial Discharge & Improper Waste Disposal:** Untreated or inadequately treated industrial effluents, as well as leachate from unscientifically managed landfills and hazardous waste sites, seep into aquifers.

Student Notes:

Industrial discharge in the river water

Industrial discharge stands as one of the most critical contributors to river pollution in India, severely impacting the ecological health and utility of numerous water bodies.

- **Common Pollutants:** Such industrial discharges typically include heavy metals (e.g., lead, mercury, cadmium, chromium), toxic chemicals (e.g., dyes, phenols), organic compounds, and hot water, all severely impacting river ecosystems and human health downstream.
- **Case studies:**
  - **River Kali, Uttar Pradesh:** This river, flowing through industrial belts like **Muzaffarnagar, Meerut, and Ghaziabad**, is a stark example of heavy metal and chemical contamination from distilleries, sugar mills, paper mills, and other industries. Its waters are often black and devoid of aquatic life, rendering it unusable for irrigation or drinking in many stretches.
  - **Noyyal and Bhavani Rivers, Tamil Nadu:** These rivers in the textile hub of Tiruppur have suffered severe pollution from dyeing and bleaching units. Untreated effluents containing dyes, salts, and chemicals have rendered vast tracts of agricultural land infertile and contaminated groundwater in surrounding areas.

Rally for Rivers programme

"Rally for Rivers" is a campaign aimed at revitalizing India's rivers, which are considered the country's lifelines, and transforming the lives of over 143 crore people. Its primary goal is to plant 242 crore trees across the country along river banks to help recharge groundwater levels and prevent water scarcity.

Namami Gange programme

The **National Mission for Clean Ganga (NMCG)** is the implementing agency for the Namami Gange Programme, a flagship initiative by the Government of India to reduce pollution and rejuvenate the Ganga River.

Progress and Challenges:

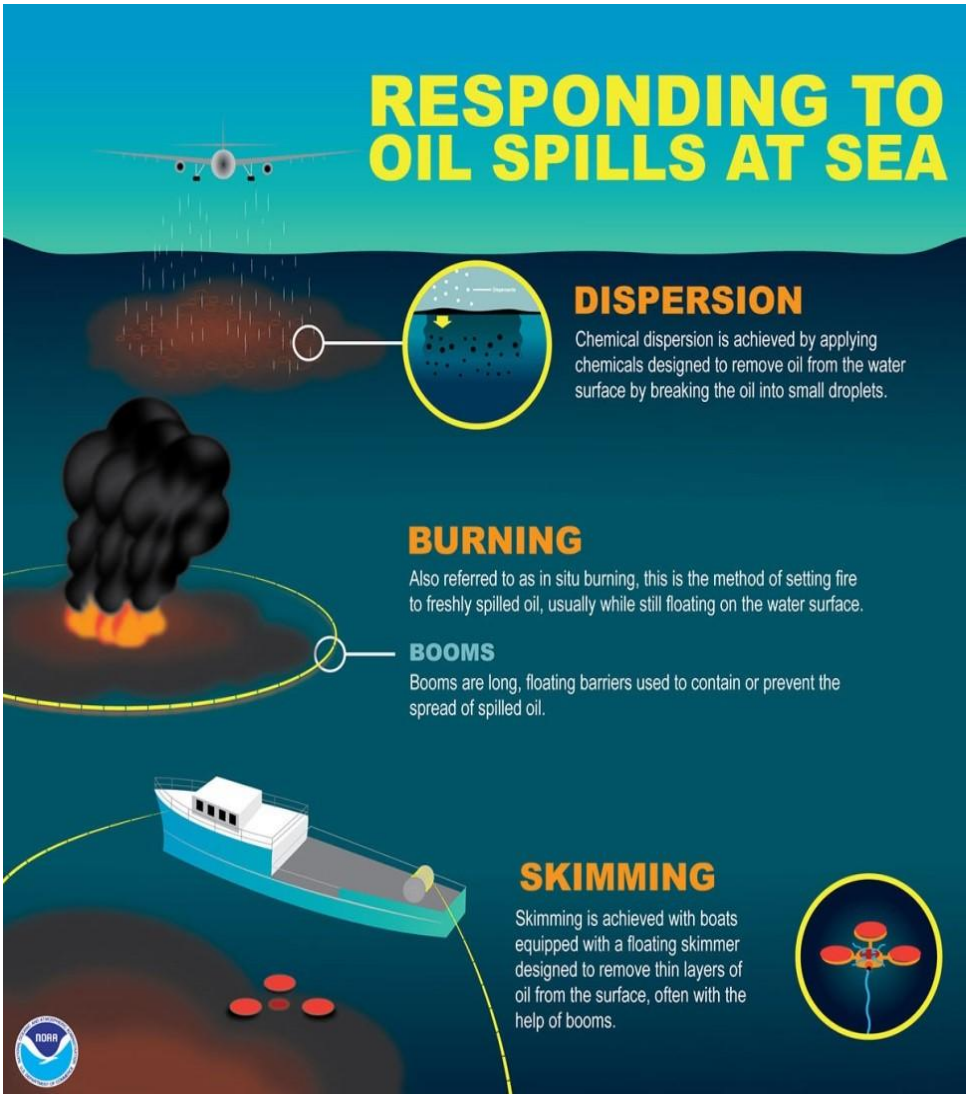
- **Sewage Treatment:** A significant focus is on sewage treatment. As of March 2025, 127 STP projects have been completed and made operational.
  - However, in 2022, the National Green Tribunal (NGT) observed that untreated waste continues to be discharged in 60% of the Ganga.
- **Industrial Pollution:** The NMCG also addresses industrial pollution through Common Effluent Treatment Plants (CETPs).
- **Funding and Implementation:** While the program has a substantial budget, allocated funds have been underutilized in some years. Effective implementation requires coordination among multiple agencies and states.
- **Monitoring and Data:** While manual monitoring is carried out at **97 stations, t**here are limitations in making the data public.

Student Notes:

2.4. Oil pollution

Oil pollution, primarily stemming from **oil spills**, represents a distinct and severe form of water pollution, especially impacting **marine and coastal ecosystems**.

- **Sources:** Major sources include accidental oil spills from tankers, offshore drilling accidents, pipeline leaks, and routine discharges from ships.
- **Impacts:** Oil forms a suffocating layer on water, devastating marine life (birds, mammals, fish) and contaminating coastlines, which cripples fisheries and tourism industries.



Recent oil spills

- **Kerala coast oil spill: A cargo ship, MSC ELSA 3,** carrying diesel and hazardous substances, recently sank off the Kerala coast, raising concerns about a potential oil spill.
- **Singapore Oil Spill (2024):** A dredging boat hit a stationary bunker vessel, causing oil to leak from one of its tanks. This led to oil slicks affecting beaches and nature reserves along Singapore's coast.
- **Tobago Oil Spill (2024):** An overturned barge, named 'Gulfstream', spilled oil off the coast of Tobago-Caribean, impacting marine life and coastal areas. The origin of the barge was initially unknown, complicating response efforts.
- **Philippine Oil Spill (2023):** The tanker MT Princess Empress sank off the coast of Oriental Mindoro, spilling over 800,000 liters of industrial fuel oil. This caused widespread environmental damage to marine protected areas, coral reefs, and fisheries, affecting thousands of livelihoods.

Student Notes:

Steps Taken to Prevent Oil Spills

Preventing oil spills is crucial for safeguarding marine ecosystems and coastal livelihoods. Both India and global frameworks implement various measures:

India

- **National Oil Spill Disaster Contingency Plan (NOSDCP):** The Indian Coast Guard formulates and implements this plan, outlining a coordinated response strategy. A recent preparedness meeting (the 25th) was conducted at Vadinar, Gujarat, on November 23, 2023.
- **Merchant Shipping Act, 1958:** This act includes specific provisions for the prevention and containment of sea pollution by oil.

Global

- **International Conventions:** Key global instruments for oil spill prevention and marine environmental protection include the **International Convention for Safety of Life at Sea (SOLAS)** and the International Convention for the Prevention of Pollution from Ships (MARPOL).
- The **International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001** (Bunker Convention), also addresses pollution from ship's fuel.
    - **India's Participation:** India is a party to all these significant global conventions, demonstrating its commitment to international maritime environmental standards.

2.5. Soil pollution

Soil pollution refers to the decline in soil quality due to the introduction of harmful substances or the loss of its inherent fertility, structure, organic matter, and nutrient-holding capacity. Globally, around 33% of soils are already degraded, with projections suggesting this could rise to over 90% by 2050 if current trends persist.

Effects of soil pollution:

- **Reduced Agricultural Productivity:** Loss of soil fertility, nutrient imbalance, and presence of toxins directly hamper crop growth and yield.
- **Food Chain Contamination:** Harmful chemicals and heavy metals from polluted soil can enter the food chain, affecting human and animal health (e.g., impact of endosulfan in Kerala's Kasaragod district).
- **Ecosystem Damage:** Disrupts soil microbial activity, harms biodiversity, and alters biogeochemical cycles.
- **Water Contamination:** Pollutants from soil can leach into groundwater or runoff into surface water bodies, exacerbating water pollution.
- **Climate Change Contribution:** Degradation leads to loss of Soil Organic Carbon (SOC), releasing stored carbon into the atmosphere and contributing to global warming.

Student Notes:

How the decline in soil health across India poses a multi-dimensional challenge to achieving Sustainable Development Goals?

The decline in soil health across India poses a **multi-dimensional challenge** to achieving **Sustainable Development Goals (SDGs)** in several ways:

- **Threat to Food Security & Nutrition (SDG 2: Zero Hunger):** Degraded soil directly reduces agricultural productivity and crop yields, impacting food availability.
- **Impediment to Climate Action & Ecosystem Health (SDG 13: Climate Action):** Loss of Soil Organic Carbon (SOC) from degraded soils turns them from carbon sinks into sources of greenhouse gases, hindering climate change mitigation.
- **Impact on Water Quality & Poverty Alleviation (SDG 6: Clean Water and Sanitation, SDG 1: No Poverty):** Pollutants from unhealthy soil can leach into groundwater or runoff into surface water, contaminating crucial water sources.

2.6. Noise Pollution

Noise pollution, often termed as invisible pollution, refers to excessive or unwanted sound that can disrupt human or animal life. While sound is essential, when it exceeds certain limits or becomes intrusive, it can have detrimental effects on health and the environment.

Student Notes:

Noise Pollution's Ecological Footprint

Noise pollution significantly impacts biodiversity and ecosystems:

- **Disrupted Behavior & Communication:** It interferes with vital acoustic communication for wildlife, affecting mating rituals, warning signals, and territorial defense. This leads to altered behaviors and displacement of sensitive species.
- **Impaired Feeding & Reproduction:** Noise hinders animals' ability to **locate prey** (e.g., echolocation disruption). Increased stress can also impact reproductive success, leading to nest abandonment and altered breeding patterns.

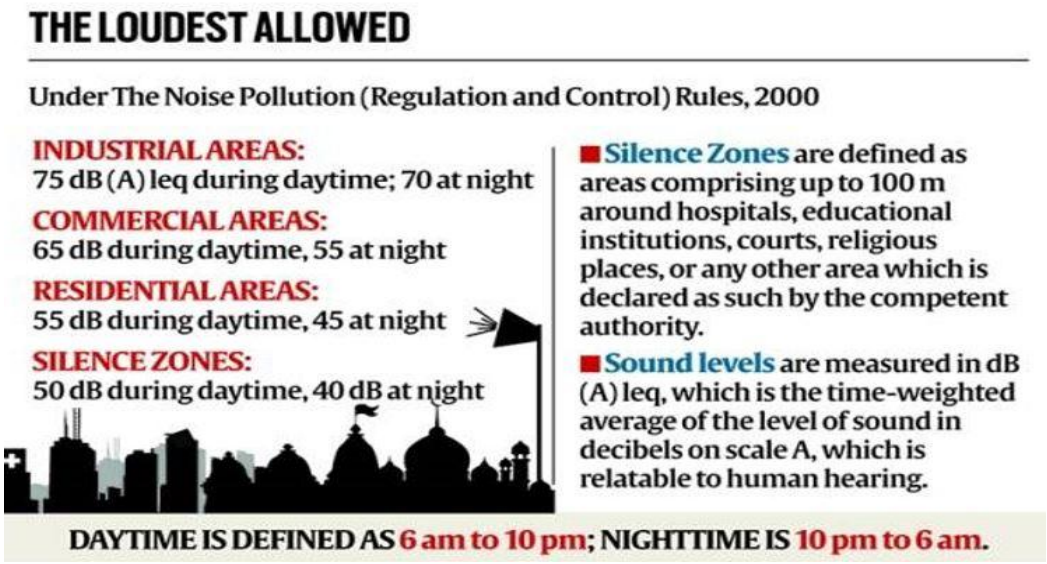
- **Ecosystem Imbalance & Biodiversity Loss:** It disrupts predator-prey dynamics and can cause a decline in overall biodiversity. Noise also affects plant growth and insect behavior (e.g., pollination), altering ecosystem functioning.

Student Notes:

Mitigation Measures

Tackling noise pollution requires a multi-pronged strategy involving regulation, planning, and public awareness:

- **Regulatory Measures:**
  - **Noise Pollution (Regulation and Control) Rules, 2000:** These rules, framed under the Environment (Protection) Act, 1986, prescribe ambient air quality standards in respect of noise for different areas (industrial, commercial, residential, silence zones). They also regulate noise from loudspeakers, public address systems, and firecrackers.

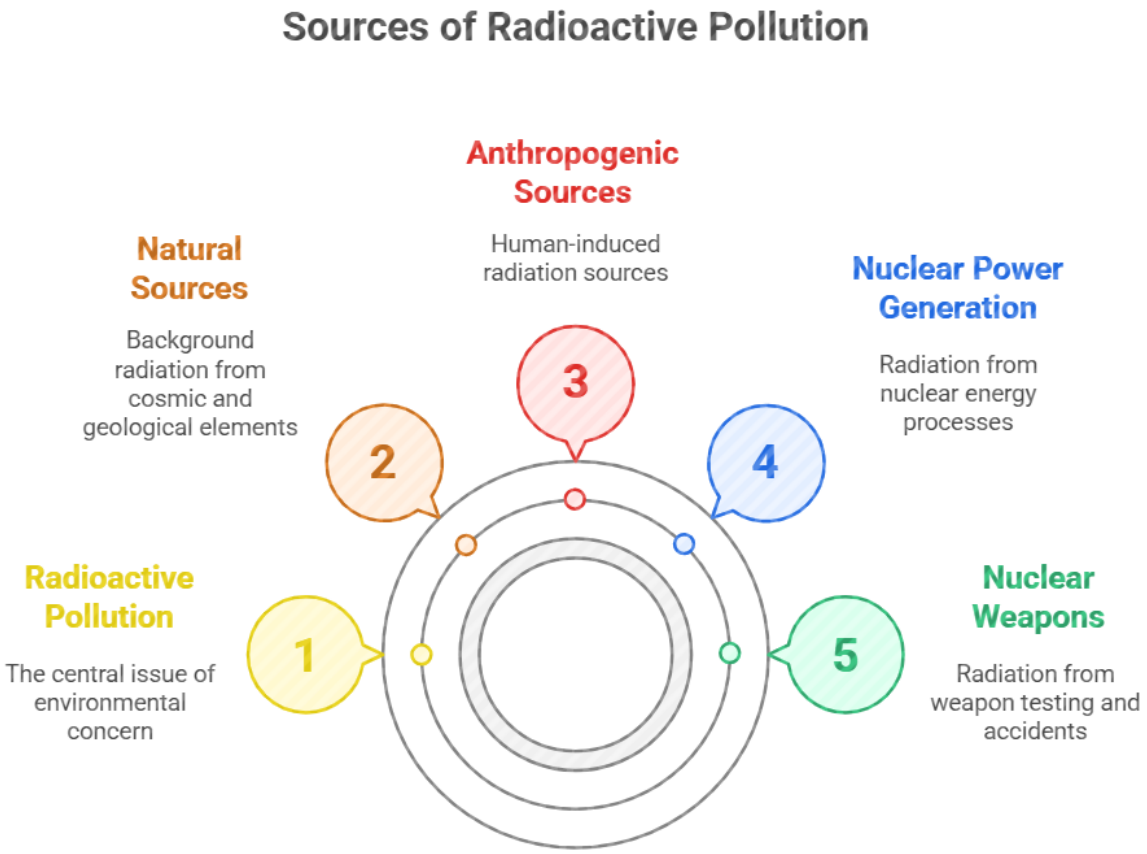


- **Urban Planning and Infrastructure Design:**
  - **Zoning Regulations:** Demarcating industrial, commercial, and residential zones to minimize noise spillover into sensitive areas like hospitals and educational institutions (designated as 'silence zones').
  - **Noise Barriers:** Construction of physical barriers along highways, railway lines, and industrial areas to absorb or deflect sound.
  - **Green Belts:** Planting trees and creating green spaces as natural noise absorbers.
- **Public Awareness and Behavioral Change:**
  - **Awareness Campaigns:** Educating the public about the harmful effects of noise pollution and encouraging responsible behavior (e.g., controlled use of horns, adherence to noise limits during festivals).
  - **Community Participation:** Involving local communities in identifying noise hotspots and implementing solutions.

2.7. Radioactive Pollution

Radioactive pollution, or radiological contamination, involves the release of radioactive substances into the environment, causing significant harm to living organisms and ecosystems. These substances emit ionizing radiation, which damages cells and DNA by removing electrons from atoms.

Student Notes:



Challenges in Management of Radioactive Waste:

Managing radioactive waste is one of the most significant challenges globally due to its unique properties:

- **Long Half-life:** High-level waste remains hazardous for tens of thousands to millions of years, requiring extremely long-term isolation.
- **High Radioactivity:** Direct human exposure is extremely dangerous, necessitating remote handling and heavily shielded facilities.
- **Public Acceptance:** Siting disposal facilities faces strong public opposition ("Not In My Backyard" - NIMBY syndrome) due to safety concerns.
- **Security Risks:** Potential for radioactive materials to be diverted for illicit purposes (e.g., dirty bombs or nuclear weapons).
- **High Cost:** Construction and operation of safe disposal facilities are immensely expensive.

Threat of radioactive pollution from the current conflicts-

The threat of radioactive pollution from current conflicts is a significant contemporary concern, primarily stemming from the risks associated with damage to nuclear facilities and the potential use of radiological materials.

- **Damage to Nuclear Power Plants:** Ongoing conflicts near operational nuclear power plants, such as the **Zaporizhzhia Nuclear Power Plant in Ukraine**, pose a severe risk.
- **Radiological Dispersal Devices (RDDs) / 'Dirty Bombs':** The concern exists that non-state actors or belligerents might employ conventional explosives to disperse radioactive material.
- **Health and Environmental Fallout:** Any significant release of radioactive substances would lead to immediate acute radiation sickness for those in proximity and long-term health effects such as cancers and genetic mutations for affected populations.

Student Notes:

Efficacy of India's current regulatory framework for ensuring nuclear and radiation safety

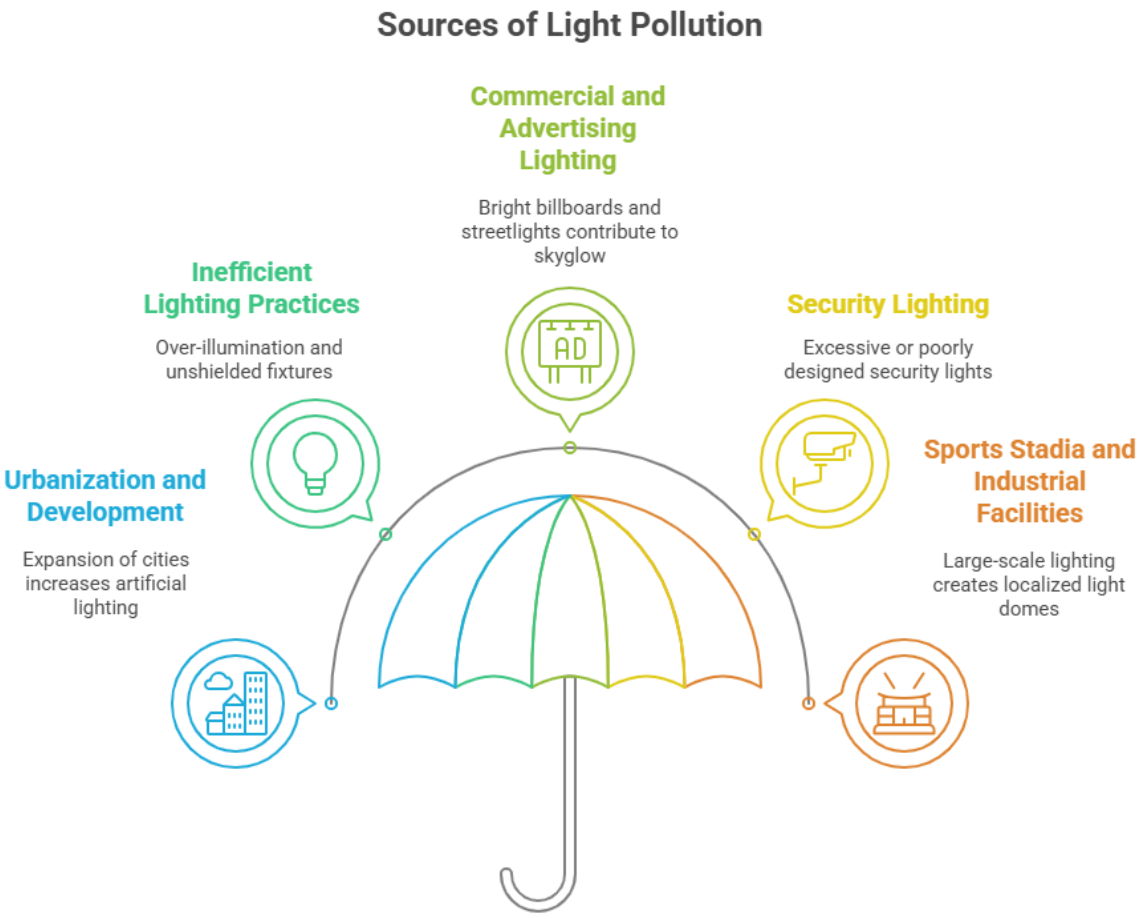
India's pursuit of nuclear energy for development necessitates a robust regulatory framework for safety. The **Atomic Energy Regulatory Board (AERB)** serves as the primary watchdog, but its efficacy is subject to critical examination.

- **Strong Operational Safety Record & Indigenous Technology:** India's civil nuclear power plants have operated for decades without a major accident, demonstrating **robust operational protocols** and significant indigenous technical capabilities in nuclear safety and design.
- **Comprehensive Regulatory Oversight:** The Atomic Energy Regulatory Board (AERB) provides vigilant oversight, establishing and enforcing stringent safety standards across all nuclear and radiation applications in India.
- **Proactive Emergency Preparedness:** Indian nuclear facilities maintain well-defined and regularly practiced **emergency preparedness and response plans,** ensuring readiness for potential contingencies and minimizing risks.
- **Civil Nuclear Liability Framework:** The framework includes the **Civil Liability for Nuclear Damage Act, 2010**, which aims to ensure **prompt compensation** for victims in the unlikely event of a nuclear accident, thereby strengthening **accountability and managing post-event consequences**.

2.8. Light pollution

Light pollution, defined as excessive or misdirected artificial outdoor light, stands as an often underestimated yet rapidly increasing form of environmental contamination.

According to the **Royal Astronomical Society,** a staggering **70% of the world's population** is exposed to light pollution, with the situation being worse in **developed countries (98%)**. Indian cities like Delhi and Mumbai are also significant contributors.



Student Notes:

Effects of light pollution:

- **Ecological Disruption:**
  - **Disruption of Circadian Rhythms:** Artificial light at night interferes with the natural light-dark cycles crucial for nocturnal animals, affecting their foraging, reproduction, and migration patterns.
    - For instance, sea turtle hatchlings can be disoriented by beach lighting, moving away from the ocean.
- **Human Health Impacts:**
  - **Sleep Disturbances:** Exposure to blue-rich artificial light at night suppresses melatonin production, disrupting **human circadian rhythms** and leading to sleep disorders.
  - **Increased Risk of Diseases:** Long-term disruption of sleep and circadian rhythms has been linked to an increased risk of **obesity, depression, diabetes, and certain cancers**.

NGT's Role in Pollution Control: Impact & Roadblocks

The **National Green Tribunal (NGT), established in 2010**, is India's specialized judicial body for environmental protection, aiming for expeditious justice.

Effectiveness:

- **Proactive & Principle-Driven:** It actively takes ***suo motu*** **cognizance**, applying principles like '**Polluter Pays' and 'Precautionary Principle**' to enhance environmental jurisprudence.
- **Enforcing Accountability:** NGT has effectively held polluters, including **industries and government bodies,** accountable through fines and specific directives for abatement and restoration.
- **Broadening Environmental Scope:** It has expanded the understanding of environmental rights under **Article 21,** addressing diverse and emerging pollution concerns.

Challenges & Limitations:

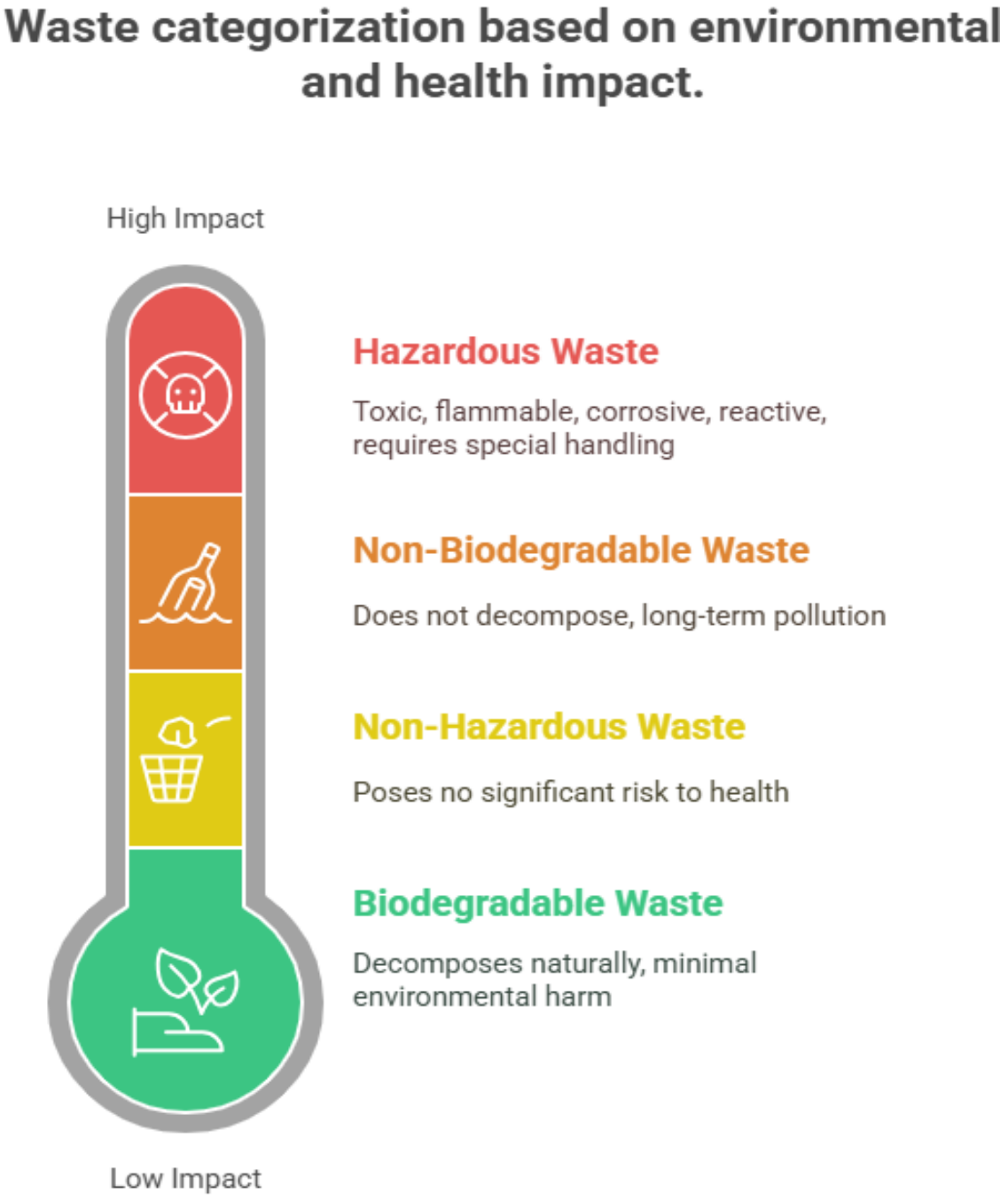
- **Enforcement Gaps:** A primary hurdle is ensuring effective implementation and compliance with its orders by **state governments and local authorities.**
- **Resource & Manpower Constraints:** NGT often faces **shortages of judicial/expert members** and limited financial/technical resources across its benches, affecting efficiency.

- **Autonomy & Coordination Concerns:** Perceived lack of complete independence from the Department of Atomic Energy for **AERB** (relevant to nuclear safety, but also extends to broader regulatory bodies) and coordination issues with other agencies persist.
- **Public Awareness & Scope:** Awareness about NGT's role remains limited among the general public, and its jurisdiction is specific to certain environmental statutes.

Despite limitations, NGT remains a vital force for environmental justice, though its full potential requires strengthened compliance and institutional support.

2.9. Waste Management: Towards a Sustainable Future

Waste, broadly defined as any discarded or unwanted material, represents a critical challenge in modern societies. Effective waste management encompasses its collection, transportation, treatment, recycling, and disposal to mitigate **environmental impacts, safeguard public health, and conserve valuable resources**.



Student Notes:

Student Notes:

Consequences of Improper Waste Management Practices

Water Pollution: Contaminates water sources affecting ecosystems and human health.

Air Pollution: Releases harmful substances like ozone-depleting chemicals, dioxins, and furans. Methane emissions contribute to climate change

Soil Pollution: Hazardous waste in landfills contaminates soil, hinders plant growth and risks human health through the food chain.

Ecosystem Disruption: Toxins harm biodiversity and disrupt natural habitats.

Economic Consequences: Increases waste management costs due to contamination.

Student Notes:

2.10. Solid Waste Management: The Urban Imperative

Solid Waste Management (SWM) involves the entire process of collecting, treating, and disposing of non-liquid discarded materials. India generates approximately **152,245 Metric Tons Per Day (MT/D)** of solid waste, with about **75% (114,183 MT/D)** being processed. Projections by the CPCB suggest annual waste generation could reach **165 MT by 2030**.

Solid waste management challenges in India

- **Fundamental Service Gaps:** Waste collection systems are often poor, particularly in rural areas, and there's limited waste separation at the source. A shortage of trained workers and low public awareness further complicate proper disposal.
- **Land Scarcity & Illegal Dumping:** Insufficient land designated for waste disposal directly leads to prevalent illegal dumping practices across the country.
- **Overlapping Jurisdiction:** Multiple government agencies share oversight, such as **MoEFCC developing rules and MoHUA** handling ground-level enforcement. This dual oversight often leads to significant challenges in coordination, funding, and consistent enforcement.
- **Technology Adoption Lag:** Modern waste management solutions like **blockchain, IoT, and AI** are not widely used in India. Their high costs and low awareness among implementers prevent broader adoption

Key Initiatives for Promoting Effective SWM

- **Smart Cities Mission:** Over 60 cities are leveraging increased technology use for **solid waste management,** leading to improved route management, collection efficiency, and daily operational management.
- **Swachh Bharat Mission (Grameen):** Phase-II of this mission specifically focuses on proper management of solid waste at the village level.
- **Swachh Bharat Mission (Urban):** Launched in 2014, this mission aims for scientific management of **municipal solid waste (MSW)** across India. Its SBM-U 2.0 iteration seeks to achieve "**Garbage Free**" status for all urban areas by 2026.

Solid Waste Management Rules, 2016: Issued by MoEFCC, under the Environment Protection Act, 1986.

- **Mandatory Source Segregation:** The rules explicitly outline guidelines for waste separation into three categories by generators: **Wet (Biodegradable), Dry (Plastic, Paper, Metal, Wood, etc.), and Domestic sanitary/hazardous wastes.**
- **Generator Responsibility:** Waste generators are legally mandated to segregate their waste at household levels and hand it over to authorized rag-pickers, waste collectors, or local bodies.
- **Emphasis on 4R Principle:** The rules promote a waste reduction strategy based on the 4R principle: **Reduce, Reuse, Recycle, and Recovery/Reclaim**, to minimize waste generation and maximize resource utilization.
- **Decentralized Management & Processing:** The rules also advocate for decentralized processing and treatment of waste as much as possible, including composting for organic waste and energy recovery through waste-to-energy processes.

Student Notes:

Waste to energy projects

Waste-to-Energy (WtE) projects involve converting various types of waste materials into usable forms of energy, such as electricity, heat, or fuel.

WtE deployment in India faces specific challenges:

- **Waste Composition & Efficiency Hurdles:** Indian solid waste typically has a **high organic fraction (~51.3%)** and **high moisture content (~46.76%)**, alongside low calorific value. This composition makes thermal WtE technologies (like incineration) less efficient and often not economically viable
- **Lack of Source Segregation:** Despite mandates under the **SWM Rules,** ineffective source segregation of waste remains a major bottleneck. Mixed waste streams contaminate recyclable and compostable fractions.
- **Environmental Concerns & Legacy Landfills:** While WtE aims to reduce landfill load, incineration-based plants can themselves become sources of **air pollution (e.g., dioxins, furans)** if not equipped with advanced emission control systems.

Landfills pose significant environmental and public health challenges

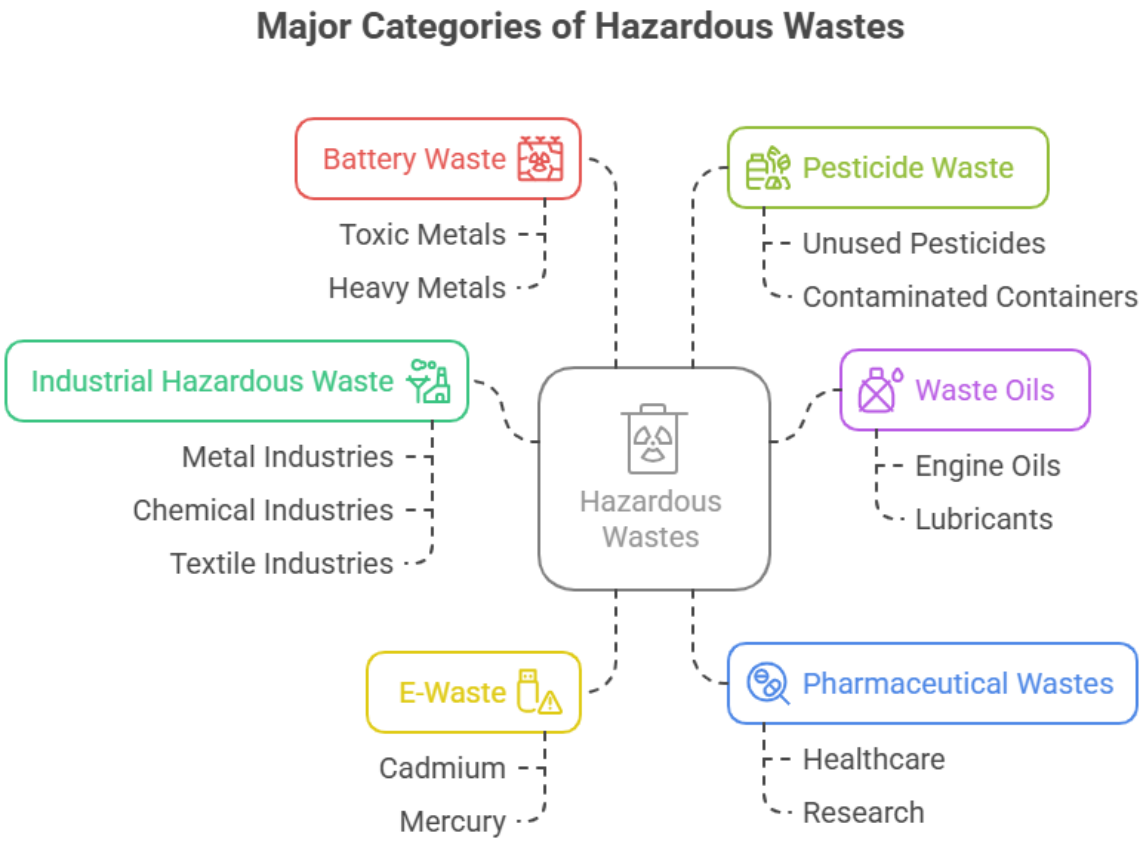
- **Environmental & Health Blight:** Overloaded, unscientific landfills lack basic infrastructure, causing **severe soil and groundwater contamination** from leachate, frequent fires, and foul odors that harm local communities.
- **Major GHG Emitters:** These sites are significant sources of methane, a potent greenhouse gas, contributing to climate change while creating local nuisances with pervasive odors and fire risks.
- **Aesthetic & Resource Loss:** They stand as unsightly urban scars, reducing quality of life and representing a massive wastage of resources that could otherwise be recovered through recycling or energy conversion.

- **High Investment & Technological Gaps:**Many WtE technologies, especially advanced thermal solutions, require high upfront capital investment, which can be a financial hurdle for municipal bodies.

Student Notes:

2.11. Hazardous Waste: Managing the Perilous Byproducts

Hazardous waste refers to materials that are dangerous or potentially harmful to human health or the environment due to their toxic, flammable, reactive, or corrosive characteristics.



- **Key Challenges:**
  - **Safe Handling & Storage:** The inherent hazardous nature demands specialized and often complex handling, storage, and transport protocols to prevent spills and exposure.
  - **Disposal Site Scarcity:** Limited availability of environmentally sound **treatment, storage, and disposal (TSD) facilities**, including secured landfills, leads to improper dumping.
  - **Informal Sector Involvement:** A significant portion of hazardous waste often enters the informal recycling channels, where workers operate without safety gear, leading to severe health impacts and environmental contamination.
  - **Transboundary Movement:** Regulating the illegal import and export of hazardous waste remains a challenge, despite international conventions.
- **Initiatives to tackle the hazardous waste:**
  - **Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016:**
    - These comprehensive rules, framed under the **Environment (Protection) Act, 1986,** regulate the generation, collection, storage, transport, treatment, import, and export of hazardous and other wastes in India.
    - Industries generating hazardous waste must obtain **authorization** from the **State Pollution Control Boards (SPCBs)** or **Pollution Control Committees (PCCs)**.
    - **Categorizes hazardous wastes** and provides standard operating procedures for each.
    - They also mandate specific responsibilities for generators, operators of **Treatment, Storage and Disposal Facilities (TSDFs)** facilities, and state pollution control boards.

Student Notes:

Challenges in Treatment, Storage, and Disposal Facilities (TSDFs):

- While TSDFs are critical components, their **availability, geographical distribution, and technological capabilities** may not meet the growing demand, particularly for complex waste streams.
- Siting new TSDFs often faces strong public opposition due to perceived **health and environmental risks**, leading to delays and reliance on existing, potentially overused, facilities.

Stricter enforcement of regulations, greater investment in safe TSD infrastructure, formalizing and upgrading the informal recycling sector, and promoting cleaner production technologies to minimize hazardous waste generation at the source.

2.12. Biomedical Waste: Healthcare's Critical Challenge

Biomedical waste (BMW) is defined as any waste generated during the diagnosis, treatment, or immunization of human beings or animals, in research activities, or in the production or testing of biologicals.

- **Scale & Risks:** India generates around **609 Metric Tonnes per day (MT/day)** of regular biomedical waste. During the COVID-19 pandemic, an additional **101 MT per day** of COVID-19-related BMW was generated.
- **Key Challenges:**
  - **Segregation at Source:** Ensuring complete and correct segregation of BMW at the point of generation within healthcare facilities remains a persistent challenge.
  - **Treatment Capacity:** Inadequate common biomedical waste treatment facilities (CBWTFs), particularly in rural and remote areas, leads to improper disposal.
  - **Compliance & Monitoring:** Effective monitoring of adherence to rules by a vast number of healthcare facilities, including smaller clinics and dispensaries.
  - **Awareness & Training:** Lack of proper training among healthcare staff and waste handlers can lead to unsafe practices.
- **Management Rules: The Bio-Medical Waste Management Rules, 2016 (and subsequent amendments, notably 2018, 2019), provide the framework. They mandate strict:**

  - **Segregation:** Color-coded bins for different waste categories.

Student Notes:

- **Collection:** Through designated common facilities or authorized agencies.
- **Treatment:** Prescribed methods like incineration for infectious waste, autoclaving for sharps, chemical disinfection, and microwave treatment.
- **Disposal:** Final residue disposal in secured landfills, adhering to environmental norms.

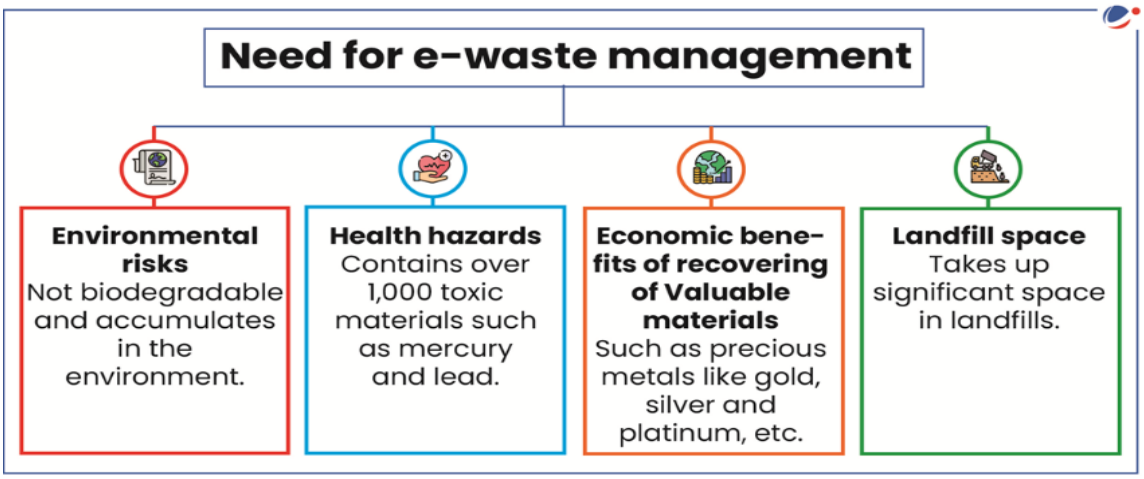
Strengthening infrastructure, rigorous enforcement of rules, continuous training and capacity building for healthcare personnel, and promoting non-incineration technologies where feasible.

2.13. Electronic Waste (E-Waste)

India witnessed a surge in electronic waste (e-waste) generation over the past five years, rising from 1 million metric tonnes (MT) in 2019-20 to 1.75 million MT in 2023-24, according to data presented by Ministry of State for **Union Ministry of Housing and Urban Affairs**.

Scale & Composition

India is the **third-largest contributor to global e-waste production**, following only China and the US. E-waste contains a complex mix of valuable materials (e.g., gold, silver, copper, rare earth elements) and hazardous substances (e.g., lead, mercury, cadmium, chromium, brominated flame retardants).



Challenges associated with E-Waste in India

- **Informal recycling:** Around 85% of e-waste is managed by the unorganized sector, primarily consisting of scrap dealers scattered across the country.
- **Inadequate e-waste management infrastructure:** There is a huge gap between present recycling and collection facilities and the quantum of E-waste that is being generated.
- **Poor awareness and sensitization:** Limited reach out and awareness regarding disposal, after determining the end of useful life.
- **Technological advancement:** A focus on electronic solutions and short product lifecycles has raised consumption and e-waste generation.

Developing Countries as Dumpyards for E-Waste

The designation of developing countries as "e-waste dumpyards" is driven by complex economic, regulatory, and ethical factors.

The Global Export Trade: An Economic Imperative:

- The primary motivation for exporting e-waste to poorer nations is the significantly lower labor costs and weaker environmental/occupational regulations.
- A US EPA pilot project estimated it was **10 times cheaper to ship CRT monitors to China** than to recycle them domestically. This economic incentive fuels illegal trade routes.

Student Notes:

Regulatory Gaps and Toothless Conventions:

- The **Basel Convention** aims to check hazardous waste trade. However, its effectiveness is undermined by **non-ratification by major e-waste generators like the US**. This allows them to export waste without being bound by the Convention's provisions.

Informal Recycling: The Double-Edged Sword in India:

- India's e-waste management is largely informal. While this sector provides livelihoods and contributes to metal recovery, it operates with crude, hazardous methods.

Case Study: New Delhi's Informal Hubs

Surveys in areas like **Mandoli and Sadar Bazar** revealed practices such as open burning of PVC-coated cables to extract copper and using acid baths (e.g., nitric acid) to recover gold/platinum. These methods release toxins, leading to severe environmental contamination and occupational hazards, often employing children.

Manufacturer Responsibility & Planned Obsolescence:

- The IT sector's rapid advancement, driven by **Moore's Law** (chip processing power doubling every 18 months), leads to **planned obsolescence**. This shrinks the average computer lifespan to less than two years, continuously fueling e-waste generation.

Mitigation & Way Forward: Towards a Circular Electronics Economy

Addressing the e-waste crisis requires a **multi-pronged approach** encompassing international cooperation, national regulation, and innovative practices.

- **Eco-Friendly Design & Manufacturer Accountability:**
  - The solution largely lies in making products eco-friendly, by manufacturing electronic goods without hazardous elements. Directives in the EU already restrict hazardous substances in electronic goods.
- **Strengthening Regulation & Enforcement:**
  - At the international level, universal ratification and stronger enforcement of the Basel Convention are needed, along with clearer definitions for e-waste.
- **Formalizing the Informal Sector:**
  - Integrating and formalizing the **informal recycling sector** is vital. This involves providing training on safe recycling practices, access to appropriate technology, and establishing proper infrastructure to mitigate health and environmental risks while retaining livelihoods.
- **Promoting Circularity:**
  - Fostering a circular economy model for electronics, which emphasizes **product longevity, repair, reuse, and high-quality recycling.** This aims to keep materials in use for as long as possible, reducing the need for virgin resources and minimizing waste.

E-Waste (Management) Rules

E-waste management in India is primarily guided by comprehensive rules that place emphasis on producer accountability and formal recycling channels.

- **Extended Producer Responsibility (EPR):** This principle mandates producers to be responsible for collecting and ensuring environmentally sound recycling of their end-of-life electronic products. The **E-Waste (Management) Rules, 2022**, further strengthen this through market-based EPR Certificates.

Student Notes:

- **Phased Collection Targets:** Producers are required to meet **mandatory and progressively increasing collection targets** for e-waste. This ensures a growing percentage of e-waste enters formal recycling chains.
- **Formalization of Recycling Sector:** The rules channel e-waste through **authorized dismantlers and recyclers**, actively promoting the formal sector. This also aims to regulate and upgrade the informal recycling segment to mitigate associated environmental and health hazards.
- **Restriction of Hazardous Substances:** Provisions are included to restrict the use of certain hazardous substances in the manufacture of **new electrical and electronic equipment**. This prevents new toxic components from entering the waste stream.

2.14. Plastic Waste Management

According to the CPCB India generated around **4,200,000 Tonnes Per Annum** plastic. Per capita plastic waste generation doubled over the last five years.

Key Challenges in the Management of plastic waste

- **Prevalence of Single-Use Plastics (SUPs):** The sheer volume and low economic value of SUPs make collection and recycling difficult, driving their high littering potential.
- **Ineffective Segregation at Source:** A major hurdle, as mixed plastic waste streams hinder efficient recycling processes and contaminate other waste fractions.
- **Collection & Processing Gaps:** Inadequate collection mechanisms, especially in rural areas, and insufficient infrastructure for processing low-value or mixed plastics.
- **Informal Sector Risks:** While contributing to recycling, the informal sector's unscientific methods cause severe environmental pollution and pose health risks to workers.
- **Lack of Assessment Mechanism:** Previously, there was a lack of mechanism for assessing current and future generation of plastic waste, leading to incomplete and invalidated data for decision-making. Plastic units also functioned without valid registration.

Plastic Waste Management Rules, 2024

The **Plastic Waste Management Rules, 2024** (PWM Rules, 2024) aim to enhance the management and reduction of plastic waste in India.

Key Provisions of PWM Rules

- **Assessment Mechanism:** Local bodies must annually assess **plastic waste generation** and estimate future plastic waste. Manufacturers of **compostable or biodegradable plastics** must report market quantities and pre-consumer waste to CPCB.
- **Centralized Portal for Registration:** Online portal for registration of **Producers, Importers, Brand-Owners, and manufacturers** of compostable plastics. Default registration if not completed within 30 days.
- **Elimination of Single-Use Plastics (SUP):** Local bodies must take measures to prevent the use and sale of prohibited SUPs, with annual reporting on progress.
- **Expansion of Extended Producer Responsibility (EPR):** Producers, Importers, and Brand Owners are responsible for collecting plastic packaging waste. Local bodies handle waste infrastructure, with voluntary engagement from stakeholders.

3. CLIMATE CHANGE

Student Notes:

Previous Year Questions (PYQ's)

1. The Intergovernmental Panel on Climate Change (IPCC) has predicted a global sea level rise of about one metre by AD 2100. What would be its impact in India and the other countries in the Indian Ocean region? (2023)
2. Discuss global warming and mention its effects on the global climate. Explain the control measures to bring down the level of greenhouse gases which cause global warming, in the light of the Kyoto Protocol, 1997. (2022)
3. Explain the purpose of the Green Grid Initiative launched at the World Leaders Summit of the COP26 UN Climate Change Conference in Glasgow in November 2021. When was this idea first floated in the International Solar Alliance (ISA)? (2021)
4. Describe the major outcomes of the 26th session of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC). What are the commitments made by India in this conference? (2021)
5. 'Climate change' is a global problem. How India will be affected by climate change? How Himalayan and coastal states of India will be affected by climate change? (2017)
6. Should the pursuit of carbon credit and clean development mechanism set up under UNFCCC be maintained even through there has been a massive slide in the value of carbon credit? Discuss with respect to India's energy needs for economic growth. (2014)

PYQs Analysis

UPSC's approach to climate change questions blends **international frameworks with India-specific vulnerabilities**, demanding awareness of both policy architecture and ground realities.

- **International Agreements & India's Commitments:** Questions from 2021 and 2022 focus on global efforts like **COP26, Kyoto Protocol**, and **Green Grid Initiative**, highlighting the need to understand **India's climate diplomacy, energy transition goals**, and role in alliances like **ISA**.
- **Climate Vulnerabilities & Regional Impact:** Questions from 2017 and 2023 emphasize the **physical and socio-economic impacts of climate change**, particularly on **Himalayan ecosystems, coastal zones, and low-lying nations** of the Indian Ocean, showing UPSC's interest toward **region-specific climate risk awareness**.
- **Market Mechanisms & Mitigation Tools:** The 2014 and 2022 questions on **carbon credits** and **GHG mitigation** indicate interest in **economic tools under UNFCCC**, pushing aspirants to balance **developmental needs with climate obligations**.

3.1. Climate change

Climate change refers to a long-term shift in average **weather patterns** including temperature, precipitation, wind, and other atmospheric conditions, occurring over several decades to centuries. These shifts may be driven by **natural processes**, but in recent times, are **predominantly human-induced** due to activities that alter the **composition of the atmosphere**.

The IPCC (AR6) defines climate change as

> "A change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer."

3.1.1. Scientific Evidence and Indicators

The reality of climate change is no longer a debate. It is **scientifically established** through multiple streams of long-term observational data.

Student Notes:

Some Indicators:

- **Rising Global Temperatures**: Earth's surface temperature has increased by **~1.1°C since 1850** (IPCC AR6).
  - The last 8 years (2015–2023) were the **warmest on record** (WMO 2023).
- **Melting Glaciers and Ice Sheets**: **Himalayan glaciers** like **Gangotri** are retreating at ~20 m/year.
  - Greenland and Antarctic ice sheets have lost over **4000 gigatonnes of mass since 1992**.
- **Sea Level Rise**: Global sea level has risen by **~21 cm since 1901**, with **faster rise since 1993**.
  - Coastal cities like **Mumbai and Kolkata** face increasing flood risk.
- **Ocean Warming and Acidification**:Oceans absorb **90% of excess heat**, threatening coral reefs and fisheries.
  - Ocean acidity has increased by **30%** since the industrial era.
- **Increase in Extreme Weather Events**:India witnessed record-breaking heatwaves in 2022 and 2024.
  - Cyclone Biparjoy (2023) and **flooding in Himachal Pradesh** (2023) reflect this volatility.
- **Changing Agricultural Zones**: Coffee plantations are shifting from Wayanad to higher altitudes due to heat stress.
  - Wheat productivity is declining in parts of the Indo-Gangetic plains.

3.1.2. Causes – Natural and Anthropogenic

Natural Causes	Anthropogenic Causes (Human-Induced)
While **natural factors** have historically influenced the Earth's climate over millennia, they alone cannot explain the rapid changes observed in the last century. • **Milankovitch Cycles**: Changes in Earth's orbit and tilt over 100,000 years, driving glaciation and interglacial periods. • **Solar Variability**: Sunspot activity can alter incoming solar radiation. • **Volcanic Eruptions**: E.g., **Mount Pinatubo (1991)** injected aerosols into the stratosphere, causing a short-term cooling of ~0.5°C.	Since the **Industrial Revolution**, human activities have released **billions of tonnes of greenhouse gases**, significantly altering the Earth's energy balance. • **Fossil Fuel Combustion** (coal, oil, gas): Primary source of CO_2 emissions. • **Deforestation**: Depletes carbon sinks and alters local climate regimes. • **Agriculture**: Rice cultivation emits methane; excessive fertilizer use leads to N_2O release. • **Urbanization**: Leads to **urban heat islands**, altering microclimates.

- ***IPCC attributes over 90% of observed warming since 1950 to anthropogenic causes.***

3.1.3. Greenhouse Gases and Keeling Curve

The **Greenhouse Effect** is a natural process where **greenhouse gases (GHGs)** trap some of the outgoing infrared radiation, warming the planet.

Major Greenhouse Gases:

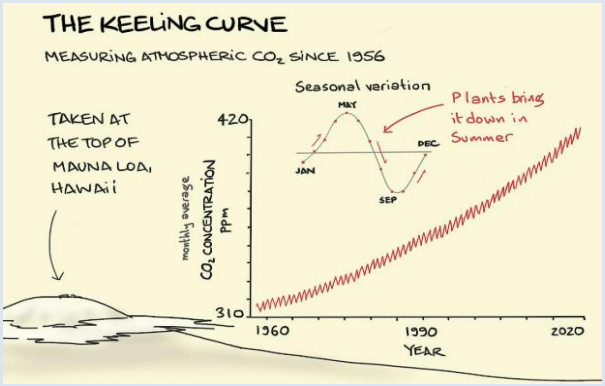
Gas	Source	GWP (100-year)	Lifetime (Years)
CO_2	Fossil fuels, land use	1	Up to 1000
CH_4	Livestock, landfills, wetlands	28–36	~12
N_2O	Fertilizers, biomass burning	265–298	~114

F-gases (HFCs, SF_6)	Refrigeration, industry	1000–23000	Up to 50,000

Keeling Curve:

A continuous record of **CO_2 concentrations since 1958**, measured at **Mauna Loa Observatory, Hawaii**.

- The curve shows **seasonal fluctuations** and a **relentless upward trend**, providing **undeniable visual evidence** of human influence.



Can Countries Be Sued Over Climate Change?

In *March 2023*, UN General assembly seeks **advisory opinion** from **International Court of Justice (ICJ)** on state obligations in climate action.

Vanuatu-Led Initiative

- Originated with **Pacific Island law students** (2019); led by **Vanuatu**, backed by **Pacific Islands Forum** & global coalition.
- Driven by **Small Island Developing States (SIDS)** seeking **climate justice**.

Key Legal Questions to ICJ

1. What are **states' legal obligations** to protect the climate for current and future generations?
2. What are the **consequences for harmful actions/inactions**, especially affecting SIDS?

Purpose & Implications

- Tool for **climate accountability** (esp. industrial nations).
- Could support **climate reparations**, **loss & damage funding**, and **climate justice frameworks**.
- Puts legal pressure on major emitters.

India's Cautious Neutrality

- **Did not co-sponsor**; wary of **top-down legal imposition** vs. **bottom-up Paris Agreement model**.
- Concerns: **sovereignty**, **legal ambiguity**, **enforceability**.
- Neighbours like **Bangladesh, Nepal, Maldives, Sri Lanka** supported it.

3.2. Global Warming

Global warming, the rise in Earth's average surface temperature due to **increasing greenhouse gas (GHG) concentrations**, is the most visible symptom of climate change. It is not a distant threat—it is unfolding now, reshaping ecosystems, economies, and human lives globally.

Climate Change vs Global Warming

Global warming is a **subset** of climate change. It refers specifically to the **increase in Earth's average surface temperature** due to the buildup of **greenhouse gases** in the atmosphere.

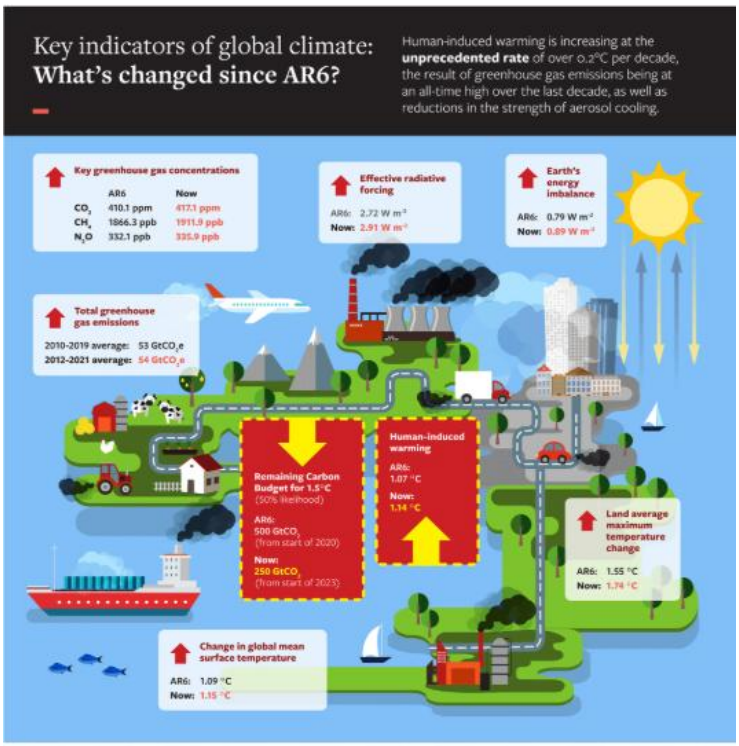
Student Notes:

Student Notes:

Aspect	Climate Change	Global Warming
Scope	Broader, includes temperature, rainfall, sea level, extreme events	Narrower, focuses only on temperature increase
Cause	Both natural and human-induced	Primarily anthropogenic (GHG emissions)
Time Frame	Decadal to millennial	Recent (since 1850s, accelerating post-1950)
Example	Changing monsoon patterns, stronger cyclones	1.1°C rise in global average temperature since pre-industrial era

3.3. IPCC AR6 Report & Synthesis Report

The **Intergovernmental Panel on Climate Change (IPCC)**, the apex UN scientific body on climate, released its **Sixth Assessment Report (AR6)** between 2021–2023. The **Synthesis Report (March 2023)** consolidates its findings.



Key Takeaways:

- **Warming Level**: Global surface temperature has already risen by **1.1°C** compared to 1850–1900.
- **Human Responsibility**: "**Unequivocal** that human influence has warmed the atmosphere, ocean, and land."
- **Climate Sensitivity**: Doubling of CO_2 is likely to cause 2.5–4°C warming.
- **Carbon Budget Shrinking**: Only **500 Gt CO_2** can be emitted to have a 50% chance of limiting warming to 1.5°C.
- **Climate Injustice**: Countries with **lowest emissions** are facing **highest vulnerability**.

*The IPCC warns that "**the window for action is closing rapidly**," but the tools for a just, sustainable future are already available.*

3.3.1. Recent Warming Trends

According to the **World Meteorological Organization (WMO)** and **NOAA (U.S. National Oceanic and Atmospheric Administration)**:

- **2024** was the **hottest year ever recorded**.
- The **decade 2011–2020** was the **warmest on record**.
- **Global average temperature** was ~**1.45°C** above pre-industrial levels in 2023.

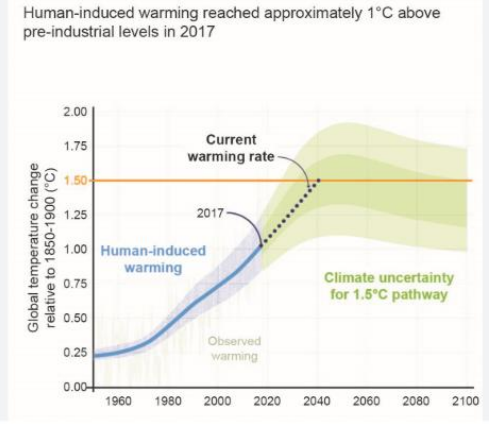
Student Notes:

Global Heat Records and the 1.5°C Threshold

The **1.5°C limit** was set under the **Paris Agreement** to avoid catastrophic climate impacts. Crossing it would:

- Increase **heat-related deaths**, especially in tropical countries like India.
- Push many species and ecosystems beyond recovery (e.g. coral reefs).
- Amplify **non-linear tipping points** (ice sheet collapse, Amazon dieback).

The **Earth has already warmed by 1.1–1.2°C**, and **temporary overshooting of 1.5°C is expected by 2030**.



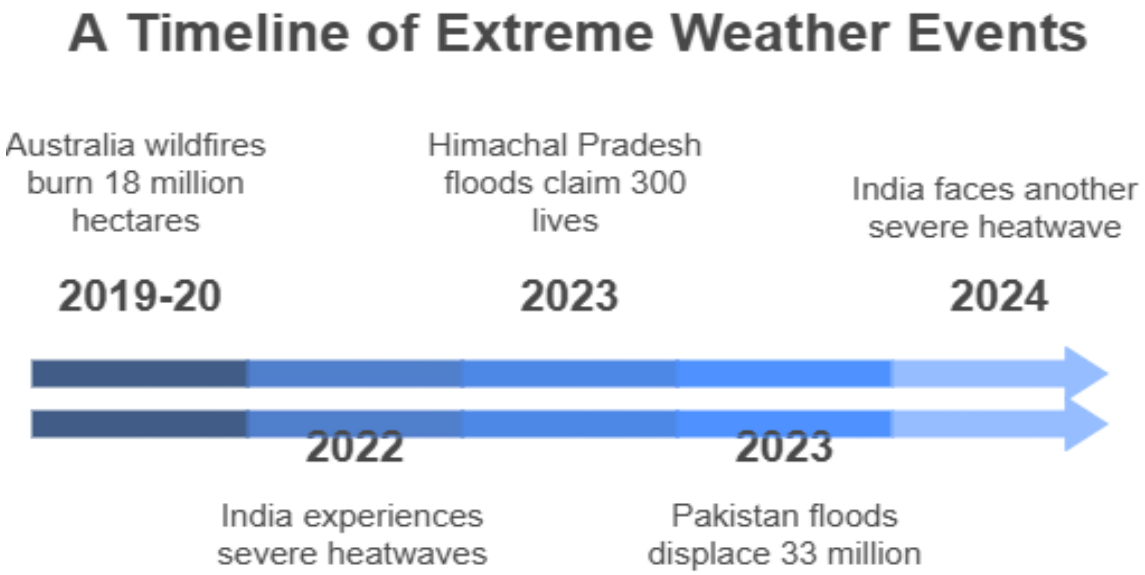
2024 Global Carbon Budget: Only Six Years Left for 1.5°C Target

The **2024 Global Carbon Budget** warns that the world has just **six years** left to limit warming to **1.5°C**, a key Paris Agreement goal. If current emissions continue, the carbon budget will be exhausted by: **2030 for 1.5°C**, **2038 for 1.7°C**, and **2051 for 2°C**.

- In 2024, **fossil CO_2 emissions hit an all-time high** of **10.2 GtC** (up 0.8% from 2023), driven by rising **natural gas (+2.4%)**, oil, and coal use. While US and EU emissions declined, **India's emissions rose to 0.9 GtC**, equalling the US amid its development surge.

Implications

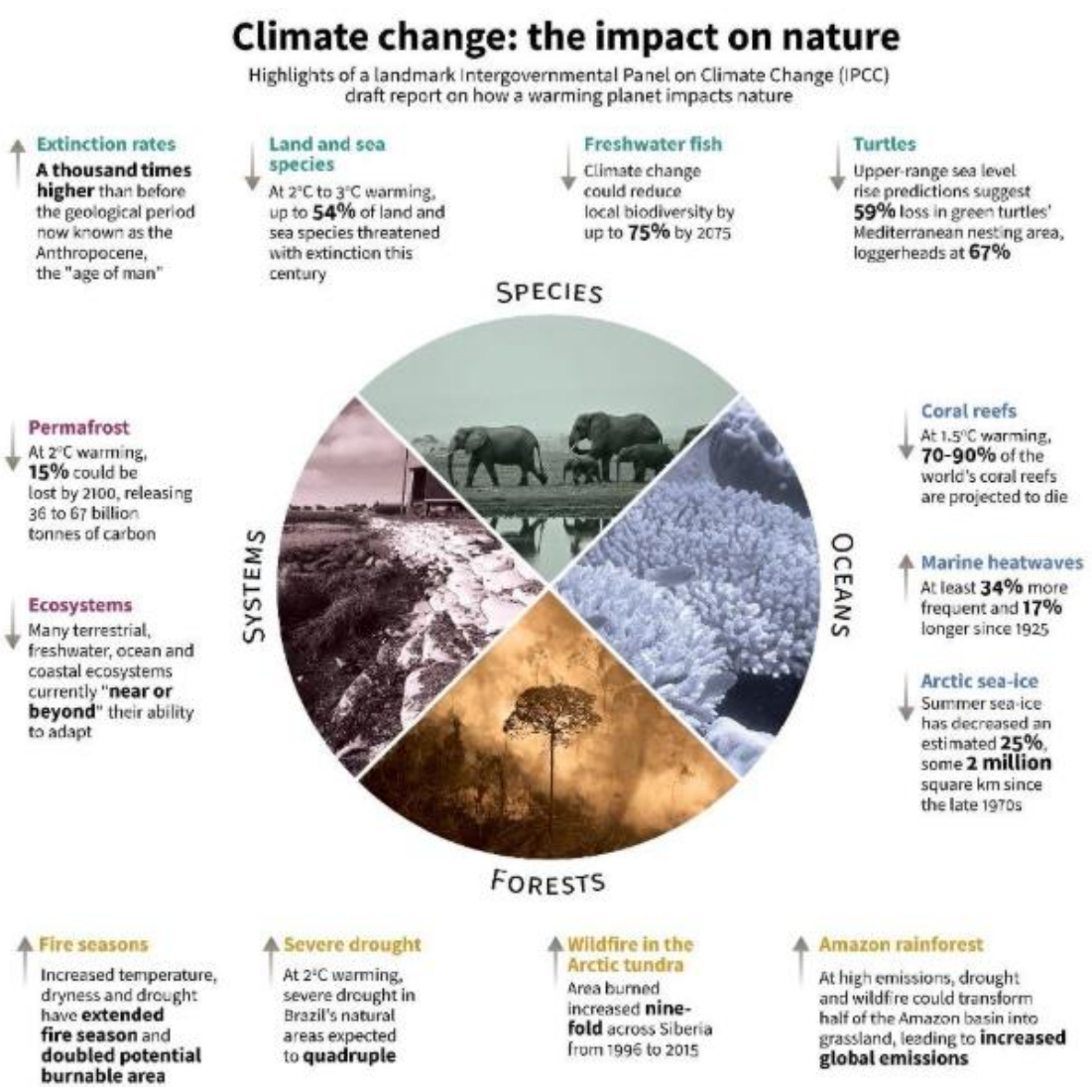
- The policy window for gradual action is **rapidly closing**.
- **Deep decarbonization**, not offsets, is the only path.
- A **just transition** is critical as pressure mounts on emerging economies like India.



3.4. Impact of Climate Change

Climate change is not a distant probability, it is a **present and accelerating crisis** with complex, interconnected consequences. The impacts are **multidimensional**, affecting everything from natural ecosystems to global health, food systems, infrastructure, and geopolitics.

Student Notes:



How are frequent wildfires under a warming climate turning forests into carbon emitters rather than carbon sinks?

Forests, once considered reliable carbon sinks, are increasingly turning into **super carbon emitters** due to rising temperatures and the growing frequency and intensity of wildfires.

- According to a 2025 UN University policy paper, current global **carbon mitigation policies fail to reflect wildfire emissions** accurately.
- Forest-based carbon markets (like VCMs, REDD+, VCS) **assume forests are stable sinks**, but frequent fires are reversing this assumption.

Examples:

- **Canada (2023)**: Wildfires burned 18.5 million hectares and released **2 gigatonnes of CO_2**, nearly **three times** the nation's economic emissions and **23% of global wildfire emissions** that year.
- **Siberia (2024)**: Taiga forests saw the **third-highest emissions in 20 years** during the hottest year on record.

Implications:

- **Afforestation isn't always a solution**; in dry, hot regions, it may **worsen emissions**.
- Blindly expanding forests without assessing hydrology, precipitation, or fire risk can be counterproductive.

Student Notes:

Way Forward:

- Rework carbon schemes to consider **climate-driven forest vulnerability**.
- Integrate **real-time satellite monitoring** to exclude high-risk areas from carbon offset markets.
- Move from one-size-fits-all afforestation to **climate-adaptive forest governance**.

Impact on Human Health

- Heatwaves now kill more people globally than floods or cyclones.
- Vector-borne diseases like **malaria and dengue** are spreading into newer regions due to warmer winters and extended monsoons.
- **Mental health issues** rise in disaster-prone zones.
- Malnutrition and undernutrition increase as food systems get stressed.

WHO warns that **climate change could cause an additional 250,000 deaths per year between 2030–2050**, from heat stress, diarrhea, malaria, and childhood malnutrition.

How is climate change contributing to gender-based violence?

Climate change is **intensifying gender-based violence (GBV)**, especially against women and girls, by amplifying vulnerabilities related to displacement, poverty, and disasters.

- According to the **UN Spotlight Initiative (2025)**, **each 1°C rise** in global temperature leads to a **4.7% increase in intimate partner violence (IPV)**.
- If global warming reaches **2°C**, up to **40 million additional women** may face IPV annually by 2090; this number **doubles under 3.5°C**.

Key Drivers:

- **Extreme weather**, **displacement**, **food insecurity**, and **economic instability** heighten stress and reduce safety, particularly in fragile communities.
- **Femicide rates rose by 28%** during heatwaves.
- **Climate disasters** increase risks of **child marriage, trafficking, and sexual exploitation**, especially in flood and drought-prone regions.

Vulnerable Groups:

- **Women in poverty, Indigenous women, LGBTQ+ individuals**, and **women with disabilities** face the highest risk due to lack of access to shelters, healthcare, or protection.

Examples:

- In **Sub-Saharan Africa**, IPV could **triple** by 2060 under a 4°C scenario.
- In **Guatemala** and the **Philippines**, women environmental defenders face **evictions, threats, and violence** for protesting deforestation and mining.

Solutions:

- Integrate **GBV prevention into climate policy** — from **national adaptation plans** to **disaster relief**.
- Successful examples:
  - **Mozambique** uses mobile health clinics in climate-affected areas.
  - **Haiti & Vanuatu** train midwives for **green jobs** and embed GBV services into climate response.

Climate change is not gender-neutral, it deepens existing inequalities and exposes women to heightened violence. **Gender-responsive climate action is essential** for building true resilience and justice.

Student Notes:

Climate Migration: A Humanitarian Crisis in Motion

The **World Migration Report 2024**, released by the United Nations, projects that **over 216 million people** could be displaced **within their countries by 2050** due to climate-related pressures. This staggering figure highlights how climate change is emerging not just as an environmental issue but as a **driver of mass human mobility**.

Understanding Climate as a Risk Multiplier

Climate change is rarely the sole cause of migration. However, it acts as a **threat multiplier**, compounding **existing vulnerabilities** like:

- Food insecurity
- Political instability
- Poor governance
- Social marginalisation

As these systemic pressures intensify, **migration becomes an adaptation strategy**, particularly in fragile regions of the Global South.

Key Findings

- **Asia**:
  - **Pakistan (2022 floods)**: 1,700+ deaths, **8 million displaced**.
  - **Bangladesh**: Over **1.5 million displacements** due to disasters in 2022.
  - **India**: At the frontline of both **climate vulnerability** and massive **remittance flows**, with $111 billion received in 2022 — the **highest globally**.
- **Americas & Caribbean**:
  - Brazil saw **700,000 displaced** in 2022 alone due to floods.
  - Colombia reported **281,000 climate-induced displacements**.

The report emphasizes that **migration must be integrated into climate policy frameworks**:

- Recognise it as a **legitimate adaptation mechanism**.
- Build **resilient local infrastructure** to absorb displaced populations.
- Ensure **climate justice** — especially for vulnerable communities with limited means to relocate or adapt.

Climate migration is **no longer a future possibility — it is a present reality**. As the world inches closer to irreversible climate tipping points, addressing displacement will require **urgent international cooperation**, **proactive adaptation planning**, and a **people-centred development approach**.

3.4.1. India-Specific Impacts

Himalayan Ecosystem and GLOFs	**Indian Monsoon & Agriculture**	**Sea-Level Rise and Island Vulnerability**	**Urban Heat Island (UHI) Effects**
The Himalayas act as India's **water tower**, biodiversity hotspot, and climate regulator. Warming of 0.3–0.5°C per decade here is: • Causing **early snowmelt**, flash	The monsoon has become **erratic and intense**, threatening India's **rainfed agriculture**, which supports over 50% of the population.	• **Lakshadweep** faces land submergence risks: Kavaratti, Minicoy may lose **60% of land** under RCP8.5. • **Sundarbans**: Over **1.5 million**	• Cities like **Delhi, Ahmedabad, Nagpur** experience night temperatures 4–5°C higher than surrounding areas.

floods, and biodiversity stress. • Accelerating **Glacial Lake Outburst Floods (GLOFs)**—e.g., Chamoli (2021), Lhonak (2023). • Endangering fragile mountain communities and tourism hubs.	• Incidents of **monsoon droughts and cloudbursts** are rising. • Early/late onset of monsoon disrupts sowing and harvesting. • E.g., Punjab saw **excess rains in July 2023**, leading to delayed paddy transplantation and yield loss. *By 2050, rice yields may decline by 10–15%, and wheat by 20% unless adaptation is adopted.*	**people** are climate refugees due to salinization, cyclones, and land loss. • India's **port infrastructure** worth billions is exposed to tidal and cyclonic hazards	• Caused by **concrete surfaces**, lack of vegetation, and **heat-trapping pollution**. • Health impacts: dehydration, cardiovascular stress, higher cooling demand.

3.5. Climate Change Governance

International climate governance is anchored in a complex architecture of **treaties, institutions, and cooperative mechanisms** designed to collectively address global warming.

3.5.1. UNFCCC

The **United Nations Framework Convention on Climate Change (UNFCCC)**, adopted in **1992** at the Rio Earth Summit, laid the foundation for global climate governance. It emerged with three guiding principles:

1. **"Common but differentiated responsibilities"** – Recognizing varied capabilities and historic emissions among countries.
2. **Precautionary principle** – Acting to prevent harm despite scientific uncertainties.
3. **Polluter-pays principle** – Ensuring those responsible for emissions bear the costs of mitigation and adaptation.

Institutional Architecture:

- **Conference of Parties (COP)** – Supreme decision-making body.
- **Subsidiary Bodies** – SBSTA (scientific/technical) and SBI (implementation).
- **Climate Change Secretariat** – Administers operations and provides support.

The UNFCCC's **core objective (Article 2): stabilise greenhouse gas concentrations** to avert dangerous anthropogenic interference. Over time, it evolved from discussing broad goals to enforcing **national commitments, transparency, financing**, and **global goal-setting** mechanisms.

3.5.1.1. Kyoto Protocol

The **Kyoto Protocol (1997) under the UNFCCC** marked the first legally binding effort to reduce emissions.

- Covered **37 industrialised nations**, aiming for an **average 5% reduction below 1990 levels** during 2008–2012.

Student Notes:

- Introduced **market-based mechanisms**: Emissions Trading, Clean Development Mechanism (CDM), and Joint Implementation.

Relevance:

- Pioneered **carbon markets and global emission targets**.
- Encouraged early investment in **renewables and energy efficiency**.

Criticism:

- **Exclusion of developing nations** (e.g., India, China) limited its impact.
- Rise of the **U.S. and Canada** undermined its effectiveness when they withdrew.
- CDM attracted scrutiny for **inflated credit claims** and **limited environmental integrity**.
- Emission targets were often met through **outsourcing and economic downturns**, not true decarbonization.

Kyoto launched global climate discourse but fell short of delivering sustained reductions or equitable structures.

3.5.1.2. Paris Agreement

Adopted at **COP21 in 2015**, the **Paris Agreement** represented a paradigm shift:

- Aims to keep global temperature rise **"well below 2°C"**, pursuing efforts to limit it to **1.5°C**.
- Introduced **Nationally Determined Contributions (NDCs)**: voluntary, national pledges updated every 5 years.
- Includes an **enhanced transparency framework** with regular reporting.
- Mandates a **global stocktake** every five years.

While the Paris Agreement laid the foundation for a flexible, country-driven climate regime, its success depends on regular negotiations and reviews. These are undertaken through the **annual COP summits,** where progress is assessed, ambitions raised, and mechanisms refined.

3.5.2. COP (UNFCCC) Summits: From Glassgow to Baku (COP26–29)

The Conference of Parties (COP) under the UNFCCC is the **decision-making hub** of global climate governance.

3.5.2.1. COP26 – Glasgow (2021)

- **Glasgow Climate Pact**:
  - First COP to call for **phasing down unabated coal**.
  - Launched **Global Methane Pledge** targeting 30% reduction by 2030.
- **Article 6 Rulebook**: Agreed core rules for carbon trading, allowing **carbon markets** under Paris.
- **Finance**: Renewed commitment to the **US$100 billion annual pledge** (2009 promise).
- **India's Gains**:
  - Contributed to Set-up of **International Solar Alliance** expansion.
  - Emphasised support for **South–South technology transfer and finance**.

3.5.2.2. COP27 – Sharm el-Sheikh (2022)

- **Landmark**: Established the **Loss & Damage Fund**, a turning point in climate justice.
- **Implementation Focus**: Glasgow targets began translating into **National Implementation Plans**.
- **Article 6**: Continued fine-tuning of carbon-trading modalities.
- **Criticisms**: Slow delivery on funding; ambiguous modalities around the new fund.

Student Notes:

3.5.2.3. COP28 – Dubai (2023)

- **Defining Moment**: For the first time, the final text called for a **"phase-down of fossil fuels"**—a major win led by COP28 presidency.
- **Global Stocktake**: Positive outcome signalling the need to **triple renewables**, **double energy efficiency**, and reduce emissions **43% by 2030**.
- **Finance**: Pledged around **US$430 million** to the Loss & Damage Fund.
- **Critique**: Implementation lacks sufficient funding and binding timelines.

3.5.2.4. COP29 – Baku (2024)

Held amidst geopolitical tensions and the shadow of a looming Trump presidency, COP29 was informally branded the **"Finance COP"**, with finance and carbon markets taking centre stage.

Key Outcomes:

- **New Collective Quantified Goal (NCQG)** on Climate Finance:
  - Mandates **US$300 billion/year by 2035**, and establishes a roadmap to reach **US$1.3 trillion/year through public and private sources**.
  - India's stance: called for **equity**, stronger adaptation focus, and emphasized **grant over loan** funding.
- **Article 6 – Carbon Markets Finalised**:
  - Agreed on **6.2 transfers** (ITMOs) and **6.4 crediting mechanism** with clear integrity and **indigenous/community safeguards**, and a global registry.
- **Mitigation & Adaptation**:
  - Launched a global **mitigation work programme** and high-level **adaptation dialogue**, though lacking strong operational indicators.
- **Loss & Damage**:
  - The Fund becomes **operational**, expected to start disbursements in **2025**.
- **Gender & Justice**:
  - Extended the **Gender Action Plan**; advanced work under the **Just Transition agenda**.

Analysis:

- **Positives**: Full operationalisation of carbon markets and finance framework moves climate finance into a new realm.
- **Critiques**:
  - US$300 billion target **falls far short** of needs (~US$1 trillion/year by 2030)
  - Language binding for US$300B, but only **"calls on"** for US$1.3 trillion develop funding channels.
  - Geopolitical rifts surfaced, with objections by India, Nigeria, and others over process fairness.
- **Outcome**: COP29 cemented finance and market mechanisms, but **ambition and equity remain in question**.

Among its many outcomes, COP29 marked a watershed moment by finalising long-pending rules under Article 6—setting the stage for a global carbon market rooted in integrity and transparency.

3.5.2.5. Article 6 Mechanism and Carbon Markets

The **Article 6 framework** under the Paris Agreement supports cross-border cooperation and carbon trading:

- **Article 6.2**: Bilateral or multilateral **cooperative approaches** through Internationally Transferred Mitigation Outcomes (ITMOs).
- **Article 6.4**: A UN-supervised global **crediting mechanism** managing high-integrity credits and channelling proceeds into adaptation.

Student Notes:

- **Article 6.8**: Supports **non-market approaches** such as capacity building and technology sharing.

Developments:

- COP26 set initial rules (Article 6 Rulebook). COP27 clarified **reporting modalities** and confidentiality rights.
- COP29 finalised **Article 6.4 standards**, including environmental, social, and **indigenous rights safeguards**.

Carbon markets now incorporate:

- **Robust tracking, registry systems, and transparency obligations.**
- A percentage of proceeds dedicated to **adaptation funding**.
- **Governmental authorizations** for credit issuance and transfer.

While carbon markets provide tools for mitigation and cooperation, parallel efforts have focused on addressing irreversible climate impacts through the Loss and Damage Fund.

Agri-Carbon Markets: Farming Carbon, Cultivating Change

As India moves toward low-carbon development, agriculture-based carbon markets are emerging as tools to reduce emissions and boost rural incomes.

By adopting eco-friendly practices—like agroforestry, zero tillage, and micro-irrigation—farmers can earn **carbon credits**, monetized in compliance or voluntary markets (e.g., Verra). NABARD has already initiated pilot projects.

However, success depends on two key principles:

- **Additionality** (credits only for new practices)
- **Permanence** (benefits must last, e.g., stored soil carbon)

Despite over 50 projects across 1.6 million hectares, no tradable carbon credits have been issued yet. Ground studies in Haryana and MP reveal systemic flaws: exclusion of SC/STs (only 13% participation), minimal female involvement (4%), poor training (60% untrained), and zero payments to 99% of enrolled farmers.

- Startups like "Carbon Core" have shown better results than large corporate projects but remain less inclusive.

Way Forward

To scale impact:

- Prioritise inclusion of smallholders
- Strengthen MRV with satellite/AI tools
- Ensure timely payments and capacity building
- Build institutional synergy between ICAR, NABARD, and local agencies

3.5.2.6. Loss and Damage Fund

A significant milestone at **COP27 (2022)** was establishing the **Loss and Damage Fund** to assist vulnerable nations facing irreversible climate impacts.

- Operates under the **Warsaw International Mechanism (WIM)**, utilizing the **Santiago Network** for technical support.
- COP29 declared it **ready to receive contributions**, with plans to disburse grants from **2025 onwards**.
- Early pledges include **$700 million** post-COP28, though high-income nations have yet to deliver on large-scale commitments.

Student Notes:

The Fund underscores the shift from **voluntary support** to **formalised climate justice**, addressing both **economic losses** (infrastructure, agriculture) and **non-economic losses** (cultural heritage, displacement).

3.6. India's Climate Policy & Commitments

India's climate policy is a layered and evolving framework that blends development goals with environmental responsibility. It includes national and state-level missions, updated NDCs, and a net-zero target for 2070.

3.6.1. National Action Plan on Climate Change (NAPCC) – 8 Missions

Launched by PM Manmohan Singh in **2008**, under the **Prime Minister's Council on Climate Change**, India's **NAPCC** outlines **eight missions** balancing **mitigation and adaptation**:

- **National Solar Mission** – Expanded solar capacity to **100 GW** by 2022; led growth to > 80 GW by 2025.
- **National Mission for Enhanced Energy Efficiency (NMEEE)** – Introduced **PAT**, **ESCO promotion**, and **ESCO financing**; targets ~229 Mt CO_2 abatement/year.
- **National Mission on Sustainable Habitat** – Emphasises waste management, urban transport, and energy-efficient buildings.
- **National Water Mission** – Aims to **increase water-use efficiency by 20%**; focuses on basin-level planning.
- **Mission for Sustaining the Himalayan Ecosystem (NMSHE)** – Led by DST, focusing on glacier monitoring and ecosystem conservation.
- **Green India Mission (GIM)** – Restores 5 M ha via afforestation; aims to improve forest carbon sink and livelihoods.

***New green India Mission recently launched in June 2025.**

- **National Mission for Sustainable Agriculture (NMSA)** – Promotes soil health, organic farming, rainfed agriculture, and the National Bamboo Mission.
- **National Mission on Strategic Knowledge for Climate Change (NMSKCC)** – Strengthens R&D; supports universities and Think-Tanks for climate solutions.

Implementation model: Each mission is administered through its **nodal ministry**, with convergence across urban schemes (e.g., AMRUT, SBM-U, Smart Cities) for synergy.

Student Notes:

3.6.2. State Action Plans on Climate Change (SAPCC)

Complementing NAPCC, **SAPCCs** are crafted by **29 States/UTs**, supported by DST. They align with NAPCC missions and address local vulnerabilities—like agrarian stress, urban heat islands, water scarcity, and Himalayan-specific risks. Many are tied to ongoing climate-resilient projects like **Himachal's watershed development and Sikkim's organic farming policy.**

District-level climate governance is the key to sustainable climate action in India.

India's battle against climate change is not just a national or global challenge—it is a deeply **local battle**, fought in its villages, urban neighbourhoods, coastal blocks, drought-prone talukas, and Himalayan districts.

Why is District-Level Governance Critical?

- **Climate Impacts are Local:** Heatwaves in Maharashtra, flash floods in Uttarakhand, salinity intrusion in Sunderbans, or droughts in Bundelkhand—all manifest differently across regions. Districts are the **first responders** to these events, making them central to vulnerability mapping and adaptation planning.
- **Bridging the Policy-Implementation Gap:** While NAPCC and SAPCCs have laid broad sectoral guidelines, their **on-ground execution depends on district machinery**. Without local governance integration, top-down climate action often remains aspirational.
- **Decentralization and People's Participation:** Local climate governance encourages **community ownership**, traditional knowledge integration, and convergence with rural development and livelihood schemes (e.g., MGNREGA, Jal Jeevan Mission).

Examples from the Ground: District-Led Climate Action Emerging

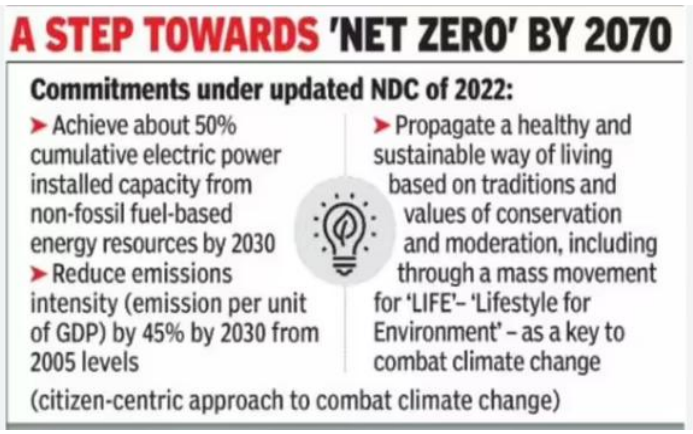
- **Chikballapur (Karnataka)** piloted **climate budgeting** under the UNDP's initiative, aligning district spending with SDGs and SAPCC goals.
- **Kanker (Chhattisgarh)** developed a **District Environment Plan** integrating tribal knowledge and forest-based livelihoods with resilience.
- **Indore (Madhya Pradesh)**, though urban, set a precedent by integrating **zero-waste and climate-resilient mobility** at the city and district levels.

3.6.3. India's Updated NDCs & Net-Zero by 2070

At **COP26 (2021)**, India announced a **net-zero target by 2070**, reflecting India's global climate ambition.

India's **revised NDCs (2022)** include ambitious goals:

- **50% non-fossil energy capacity** by 2030.
- **–45% CO_2/GDP intensity** (vs. 2005).
- **Establish 2.5–3 Gt CO_2 sinks** via afforestation by 2030.



A **non-quantified pledge** called **LiFE** (Lifestyle for Environment) promotes eco-conscious behaviour at the individual and community level.

3.6.4. Long-Term Low Emission Development Strategy (LT-LEDS)

India submitted its **LT-LEDS** at **COP27 (2022)** as the strategic blueprint to achieve net-zero by 2070. This roadmap emphasises:

Student Notes:

- Rapid **renewable energy and green hydrogen** scale-up.
- **Energy efficiency** improving > 5% annual reduction.
- Enhancing **carbon sinks** alongside socioeconomic growth.

Following UNFCCC guidelines, LT-LEDS reaffirmed India's pledge to the **CBDR-RC principle** and aligns developmental goals with climate action.

3.6.5. Green Credit Programme (GCP)

Launched in **October 2023** under MoEFCC and administered by **ICFRE**, the **Green Credit Programme** is India's **market-based ecosystem restoration initiative**. It offers **tradable "green credits"** for voluntary actions such as:

- **Afforestation and mangrove protection**
- **Water conservation**
- **Regenerative agriculture**
- **Waste management and air pollution control**
- **Ecomark compliance** on green products

Initially targeting **tree plantation** and **watershed management**, GCP is governed via a **steering committee**, a **digital registry**, and project verification protocols. It complements India's **carbon market**, aiding environmental compliance, earning foreign exchange, and nudging eco-friendly investments.

3.6.6. India's Performance in Climate Indices

Index	India's Latest Ranking/Score	Key Observations
Climate Change Performance Index (CCPI)	10th (2025)	High in GHG emissions & energy use; medium in climate policy; low in renewable energy; coal dependence remains high.
Environmental Performance Index (EPI)	176th out of 180 (2024)	Score: 27.6/100; low on biodiversity, water, and air quality; some strengths in forest integrity and agriculture.
Climate Action Tracker (CAT)	"Highly Insufficient" (2025)	India's climate targets and actions are not compatible with the Paris Agreement's 1.5°C goal; gaps in net-zero roadmap and legal frameworks.

These assessments highlight strengths—like renewable capacity and energy efficiency—alongside critical gaps in **carbon sink expansion**, **adaptation finance**, and **legislation**.

3.7. Climate Finance

Ensuring adequate, accessible, and equitable climate finance is central to the global climate architecture. This section analyses key funds, evolving structures, and India's role.

Key Multilateral Funds

- **Green Climate Fund (GCF)**:
  - Established under UNFCCC (2010) as the largest dedicated climate fund, headquartered in South Korea.
  - Supports developing countries on adaptation and mitigation. As of December 2023, GCF's portfolio stood at **US $13.5 billion**, with **$51.9 billion including co-financing**, and a pledged replenishment of **$5.33 billion (2022–2026)**.

Student Notes:

- **Adaptation Fund**:
  - Launched in 2001 (COP7/Marrakech), operational since 2007. Funded by **2% levy on CDM credits** and voluntary contributions.
  - By 2022, it committed **over $1.2 billion** across 54 countries, reaching vulnerable communities via **direct-access mechanisms**
- **Loss & Damage Funding Facility**:
  - Announced at **COP27**, intended to assist vulnerable nations in coping with irreversible losses. Formal guidelines, leveraging the **Warsaw International Mechanism**, will operationalize disbursement by **2025**, with initial pledges around **$700 million**.

Status & Gaps

Despite modest gains, significant shortfalls persist:

- COP29 discussions revealed poor fulfilment of the **$100 billion/year pledge from 2020**, and negotiations aim for at least **$300 billion/year by 2035**, with an aspirational scale of **$1–1.3 trillion/year**.
- **According to UNEP's 2023 Adaptation Gap Report:**
  - Global adaptation finance shortages range from **$194–366 billion/year**.
  - Developing countries need **$215–387 billion/year**, while actual funding was only **$21.3 billion in 2021**, marking a **15% drop**
- Current climate finance (~$1.5 trillion/year) is dominated by private flows, but only **3% reaches the poorest nations.**

Why is finance alone inadequate to solve the climate crisis? Illustrate with reference to COP29 outcomes?

The **COP29 summit (2024)**, dubbed the **"Finance COP,"** highlighted a crucial lesson, **money cannot replace nature**. The summit's failure to deliver promised financial solutions revealed the deeper **incompatibility between financial systems and ecological realities**.

Finance ≠ Nature	The False Comfort of Financial Tools	Structural Contradictions	Economic Growth & Greenwashing
• **Biophysical systems** (ecosystems, soils, climate) **cannot be substituted by capital** — a commodity created by humans. • **Carbon trading, marketisation of pollution, and risk-based insurance** instruments fail to address root ecological causes. At **COP29**, financial	• Since the **Paris Agreement (2015)**, tools like the **Loss and Damage Fund** shifted focus from emission mitigation to **risk management**. • These instruments **reinforce status quo fossil fuel reliance**, while **developing nations compete for climate finance**, often at the cost of sovereignty and environmental standards. *Example:* Rich nations often **relocate**	• The **$100 billion annual pledge** by developed nations remains unmet, showing a **gap between promises and delivery**. • Finance is used to maintain **economic growth narratives**, ignoring the **finite limits of nature**.	• Climate governance now **equates sustainability with growth**, enabling **greenwashing** by industries and states. • The transformation of **industrial capital into financial derivatives** has reduced ecological accountability, handing power to

commitments were positioned as climate panaceas, but **failed to materialise**, exposing their **structural limitations**.	**polluting industries** to developing countries through investment leverage, **externalising emissions**.		**investment banks and insurers**.

The **failure of COP29's financial promises** is a **wake-up call**: Instead of betting on money, the world must return to **nature-based solutions**, decentralised economies, and **restorative production-consumption systems**.

Carbon Credit Markets: Global & Indian Perspectives

- The global voluntary and compliance carbon markets reached a valuation of **$949 billion in 2023**, projected to soar to **$2.68 trillion by 2028** and **$22 trillion by 2050**
- Paris Agreement's **Article 6 mechanisms and carbon markets** facilitate international emissions trading, adding transparency and integrity.
- **For India:**
  - Its emerging **carbon credit trading scheme (CCTS)** was unveiled in 2023 by the Ministry of Power to prepare industries for future compliance.
  - At **PRAKRITI 2025**, the World Bank underscored that globalization of carbon pricing is crucial; India's participation positions it as a credible climate player.

Key concerns include method consistency, double counting, quality control, and ensuring community-level benefits.

Carbon Pricing in India Market Mechanisms for Climate Leadership

India is rapidly building a structured carbon pricing ecosystem through a rate-based **Emissions Trading System (ETS) and the Carbon Credit Trading Scheme (CCTS), focusing on emissions intensity rather than absolute caps.**

Supported by legal reforms, voluntary carbon markets, and initiatives like the Green Credit Programme and Mission LiFE, India aims to balance its development needs with climate leadership. These efforts position India as a key emerging player in global carbon markets.

3.7.1. CBAM (Carbon Border Adjustment Mechanism)

The EU's **CBAM**, in transitional self-reporting mode since October 2023 and set for full implementation in Jan 2026, imposes tariffs on imports covering emissions embedded in goods like steel, cement, aluminium, fertilizers, electricity, and hydrogen.

- **Implications for India**:
  - Exports of iron, steel, and aluminium to the EU (~US$8 billion annually) may face a **20–35% cost increase**.
  - Indian exports already use coal-heavy energy (~75% share), making them vulnerable compared to the EU's green supply chains.
- **India's Response**:
  - Leading multilateral objections via the **BASIC grouping**, highlighting violation of **CBDR-RC principle**.
  - Considering WTO legal challenge and bilateral negotiations for carbon tax reciprocity.
  - Plans to strengthen domestic carbon pricing (CCTS), MRV systems, green hydrogen, CCUS, and aligning coal cess with carbon pricing.

Student Notes:

3.7.2. Just Transition & Equity Debate

Just Transition aims to ensure climate action does not unfairly disadvantage workers, biomass-based livelihoods, or marginalized communities. Key principles include:

- **Acknowledgement of inequality**: India and other developing countries emphasize that developed nations, having contributed most emissions historically, must take the lead.
- COP29 discussions underscored the need to **reform global finance architecture**, mobilize **$2.4 trillion/year by 2030**, and scale up de-risking instruments and blended finance to attract private capital.
- The **Equity Debate**:
  - Demands from **Global South** for **public grants over loans**, enriched finance transparency, and technology/finance flow aligned with **CBDR-RC**.
  - Critics view unilateral carbon tools like CBAM as **protectionist**, unless accompanied by technical/financial support for lower-income nations.

3.8. Technology & Innovation for Climate Action

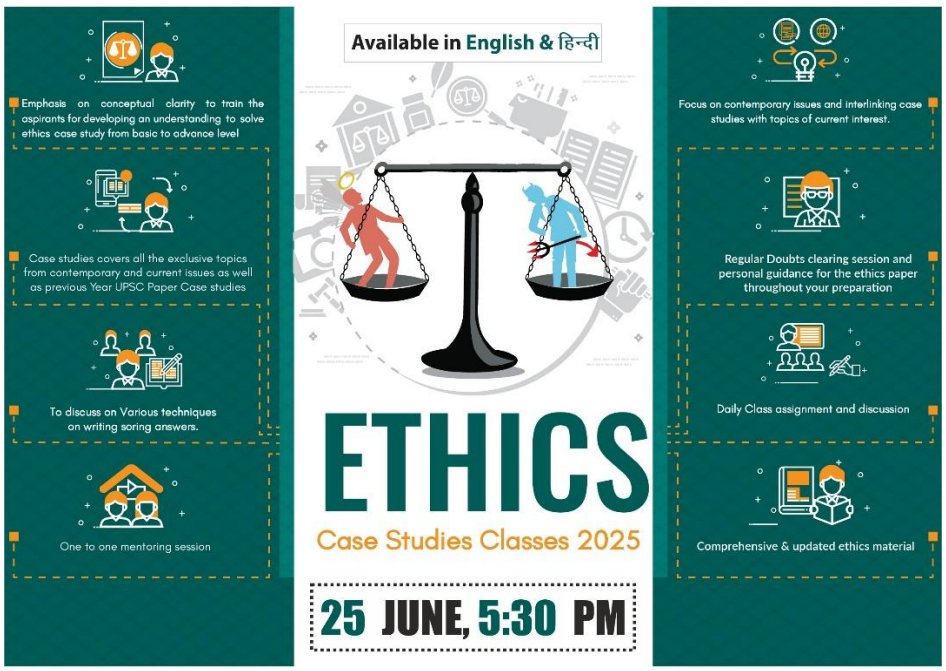
Advancing climate science isn't just about research — it's about **translating innovation into resilient economies and sustainable systems**. Here's how India is stepping up globally.

3.8.1. Carbon Capture & Storage (CCS, DACS)

CCS (Carbon Capture and Storage) and **DACS (Direct Air Capture with Storage)** aim to trap CO_2 from large emitters or directly from the ambient air.

- **India's Initiatives**:
  - **DST-led "Accelerating CCS Technologies (ACT)"** and **Mission Innovation CCUS challenge** are nurturing **pilot projects** and funding **public–private co-innovation**
  - **Tata Steel and CSIR** piloting 5 tpd carbon capture in Jamshedpur, with plans to scale to 100,000 tpa at JSW-Karnataka (supported by BHP and Carbon Clean) by 2026.
  - **ONGC–IOC joint CCUS project** at Koyali refinery in Gujarat will utilize captured CO_2 for **enhanced oil recovery (EOR)**
  - **National CCS Mission & Roadmap 2030** being prepared by the Ministry of Petroleum via MoPNG taskforce.

Challenges include high costs, lack of pipeline infrastructure, storage regulations, and traceability — yet CCUS remains vital for decarbonizing **steel, cement, power, and heavy industries** .



Student Notes:

3.8.2. Green Hydrogen & Methanol Conversion Plants

- **Green Hydrogen**: Earmarked by India's **National Green Hydrogen Mission (2024)**, with ₹19,744 cr funding until 2030. It focuses on scaling electrolysis, infrastructure, and demand creation in industries and transport.
- **Green Methanol Pilot Plant (Pune)**: A ₹100 cr PPP project with DST support, converting CO_2 and green hydrogen into **green methanol**—relevant for shipping and aviation.
- Honeywell and AM Green's February 2025 MoU includes **green methanol and sustainable aviation fuel (SAF)** development.

These projects bolster India's **energy transition**, offering cleaner alternatives and export opportunities.

3.8.3. Renewable Energy Innovations – Solar, Wind & "Green Tug" Programme

- India leads in **solar PV technology** and **wind power**, targeting **500 GW non-fossil energy by 2030**.
- **Green Tug Programme**: Innovation in eco-friendly harbor tugs using **hybrid/electric propulsion** is in pilot stages under MoPSW.
- **Avaada Group** recently raised ₹1,440 Cr through India's first AAA-rated **green bond**, funding 12 GW of solar, wind, pumped hydro, and molecular fuel plants
- IIPE's new **Energy Research Park** (Visakhapatnam) focuses on **green hydrogen, CCS, and battery materials**, funded to the tune of ₹150 Cr

3.8.4. Geoengineering & Glacial Geoengineering

Geoengineering refers to large-scale interventions in Earth's systems to counter climate change — controversial and speculative.

- **Stratospheric Aerosol Injection (SAI)**: Injects reflective particles to cool polar regions and slow glacier melt. Still **modelled**, not deployed. Raises concerns of ozone depletion, weather pattern disruption, and governance.
- **Marine Cloud Brightening (MCB)**: Involves spraying sea salt into clouds to reflect solar energy. Limited pilot studies show promise but risks include ocean ecosystem impacts and weather system disruption.
- **Cirrus Cloud Thinning & Surface Albedo Enhancement**: Emerging research includes thinning warming clouds and painting surfaces to reflect heat. Alpine glacier experiments using reflective geotextiles and microspheres show local benefits but scaling remains untested.

3.8.5. Satellite Climate Monitoring & AI-based Forecasting

- **Satellite Systems**:
  - **EUMETSAT Meteosat-Third Generation & Sentinel-4/6B**: Offer continuous observation of weather, air quality, and sea-level changes
  - **Copernicus Sentinel Program**: Supports India and global partners in monitoring emissions and ocean temperatures.
- **AI & Machine Learning**:
  - **NeuralGCM** by Google & ECMWF combines AI with physics models for improved long-term climate prediction—faster and more accurate.
  - **GenCast (Google DeepMind)** and **Atmo** deliver superior extreme weather and aerosol forecasts, aiding disaster preparedness.

Student Notes:

- AI is also being integrated in **urban disaster response, glacier monitoring, aerosol tracking**, and **heatwave forecasting** models

3.9. Climate Adaptation & Mitigation

Climate adaptation involves adjusting to current and expected climate impacts to minimize harm or exploit opportunities. This includes measures like building flood defenses, developing drought-resistant crops, and enhancing early warning systems.

Climate mitigation focuses on reducing greenhouse gas (GHG) emissions through strategies like transitioning to renewable energy, enhancing carbon sinks, and improving energy efficiency.

Global Adoption Trends

Mitigation has historically dominated climate policy due to international agreements like the Paris Agreement, which emphasize emission reductions to limit global warming. However, adaptation is gaining prominence as climate impacts intensify. Key reasons include:

- **Urgency of impacts:** Rising sea levels, extreme weather, and ecosystem disruptions necessitate immediate adaptive measures.
- **Irreversible changes:** Even with mitigation, existing GHG concentrations require societies to adapt.
- **Co-benefits:** Adaptation strategies (e.g., ecosystem restoration) often deliver multiple benefits like biodiversity conservation and livelihood security.

India's Stance and Actions

India adopts a dual approach, balancing mitigation with adaptation, while emphasizing equity and historical responsibility.

Mitigation Initiatives

1. **Emission Reduction Targets:** Committed to net-zero emissions by 2070.
2. **Clean Energy Transition:** Scaling renewable energy (solar, wind), phasing out single-use plastics and promoting clean cooking fuels.
3. **Carbon Sink Enhancement:** Forest conservation and urban afforestation (e.g., Miyawaki technique).

Adaptation Initiatives

1. **National Adaptation Plan (NAP):** First-ever NAP under development (targeting COP30 submission, 2025) to build nationwide resilience.
2. **Ecosystem-Based Adaptation (EbA):** Integrating traditional knowledge for water conservation (e.g., *Jal Shakti Abhiyan*) and coastal resilience (mangrove restoration, seaweed farming).
3. **Infrastructure and Policy Integration:** Climate-proofing agriculture, developing drought-resistant crops, and upgrading early-warning systems.

Key Priorities and Challenges

- **Equity Focus:** India stresses that developed nations should lead mitigation, while supporting adaptation in vulnerable regions.
- **Resource Constraints:** Scaling adaptation faces funding gaps, though initiatives like EbA offer cost-effective solutions.
- **Holistic Integration:** India links climate actions with sustainable development (e.g., decoupling economic growth from emissions).

India's strategy reflects a pragmatic balance: advancing mitigation to curb future risks while **prioritizing adaptation** to protect vulnerable populations from unavoidable impacts

Student Notes:

3.9.1. Ecosystem-Based Adaptation (EbA)

EbA uses biodiversity and ecosystem services to buffer climate impacts. According to IUCN and UNCBD, it integrates land, water, and resources equitably to build community resilience.

- **Agroforestry & Multilayer Farming**: Mixed planting of trees with crops (e.g., pumpkin, papaya, moringa) improves soil fertility, reduces erosion, and buffers temperature extremes. Example: Bhairab Saini in Kerala uses this model.
- **Soil & Water Retention Structures**: *Grass-hedge bunds*, *stone bunds*, and water channels improve infiltration, reduce runoff, and offer consistent crop yields.
- **Mangrove & Wetland Restoration**: UNDP-led Ladakh wetlands & Sundarbans mangroves conserve water, support biodiversity, and shield against floods .

Why it's effective: EbA creates **triple gains**—biodiversity conservation, livelihood support, and climate adaptation.

3.9.2. Urban Climate Resilience (C40 Cities)

C40—the network of 100 global cities—includes six Indian cities (Mumbai, Delhi, Bengaluru, Kolkata, Chennai, Pune).

- **Mumbai Climate Action Plan (2022)**: A 30-year roadmap aiming for net-zero emissions by 2050, covering sustainable waste, green infrastructure, flood mitigation, energy efficiency, air quality, and transit.
- **NIUA Cities' Readiness Report**: Highlights mainstreaming resilience via capacity building, budget alignment, and urban greening.

Salient Strategies: Urban wetland restoration, heat wave plans, green cover expansion, resilient infrastructure, and citizen engagement.

3.9.3. Coastal & Flood Management – Floodwatch India

India's coastal regions face rising sea levels and cyclones—requiring targeted mitigation:

- **Nature-based barriers**: Coastal wetland recharges help absorb storm surges and support aquifers.
- **Floodwatch India**: A Centre for Policy Research initiative using real-time data and predictive analytics to monitor urban floods.
- **Ice Stupa & Artificial Glaciers**: Ladakh's Sonam Wangchuk launched "Ice stupas" to store winter water in glacier-mimicking structures.

These combine **engineering, ecosystem restoration and smart planning**—a holistic adaptation approach.

3.9.4. Green Buildings & GRIHA, IGBC

Green buildings reduce resource use, emissions, and provide wellbeing-enhancing spaces:

- **IGBC by CII**: Over **8,600 projects** totaling ~10 billion sq ft, saving electricity (15 GWh/M sqft) and water (45 kL/M sq ft/year)
- **GRIHA & ECBC**: GRIHA 5-Star and ECBC standards have been adopted for government and private buildings (e.g. Indira Paryavaran Bhawan).
- **Indira Paryavaran Bhawan**: India's first on-site **net-zero building**, combining PV, geothermal, greywater systems; cuts electricity and water use by 40–55%

Student Notes:

4. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Previous Year Questions (PYQ's)

1. What role do environmental NGOs and activists play in influencing Environmental Impact Assessment (EIA) outcomes for major projects in India? Cite Your examples with all important details. (2024)
2. How does the draft Environment Impact Assessment (EIA) Notification, 2020 differ from the existing EIA Notification, 2006? (2020)
3. Rehabilitation of human settlements is one of the important environmental impacts which always attracts controversy while planning major projects. Discuss the measures suggested for mitigation of this impact while proposing major developmental projects. (2016)
4. Environmental Impact Assessment studies are increasingly undertaken before a project is cleared by the Government. Discuss the environmental impacts of coal-fired thermal plants located at coal pitheads. (2014)

PYQs Analysis

UPSC's questions on EIA highlight its evolving role as a **regulatory, participatory, and preventive tool** in balancing development with ecological sustainability.

- **Evolution of EIA Framework:** Questions like the 2020 one on **EIA 2020 vs 2006 notification** show UPSC's focus on tracking **regulatory dilution, transparency concerns**, and legal debates surrounding **public consultation and compliance timelines**.
- **Stakeholder Role & Activism:** The 2024 question marks a shift toward evaluating **civil society participation**, with NGOs and environmental movements.
- **Sector-Specific & Social Impacts:** Earlier questions (2014, 2016) focus on **project-specific impacts** like thermal power pollution or **displacement due to development**, emphasizing **rehabilitation, cumulative impact assessments**, and **sustainability safeguards** in project design.

4.1. Basics of EIA

Environmental Impact Assessment (EIA) is a **formal and structured process** used to **predict the environmental consequences** of any development project before it is undertaken.

It helps integrate environmental concerns into developmental planning at the project level.

It is mandated to ensure that **development is sustainable**, equitable, and scientifically planned—keeping in view long-term environmental and socio-economic impacts.

Key Objectives

- **Prevent environmental degradation** before it occurs
- **Ensure sustainable development** by integrating environmental concerns in project planning
- **Promote transparency and public participation** in environmental decision-making
- **Aid in informed decision-making** by providing evidence-based analysis

4.1.1. Project Classification under EIA Notification 2006

Before an Environmental Impact Assessment (EIA) is conducted, all proposed projects are classified based on their potential environmental impacts. This classification determines the level of scrutiny and the authority responsible for granting environmental clearance.

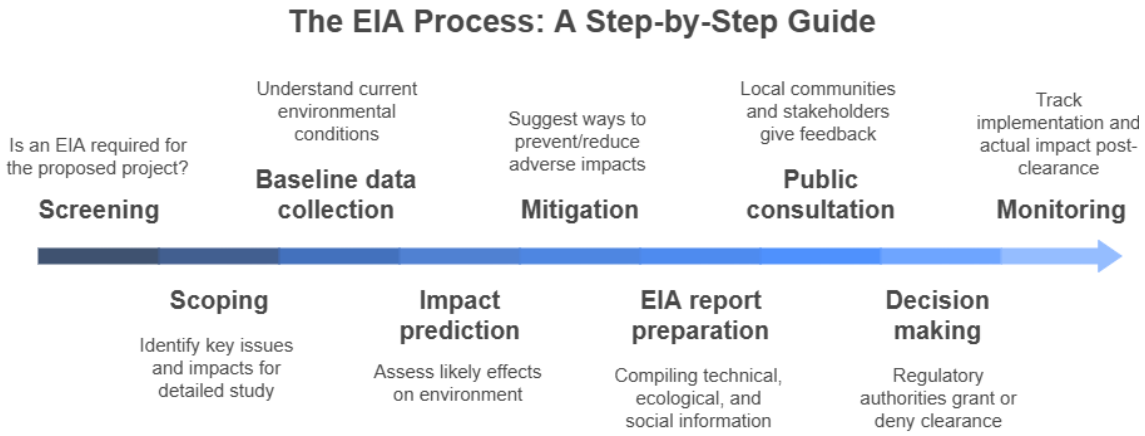
Category	Authority Responsible	Requires EIA Report?	Notes
Category A	Central Government (via Expert Appraisal Committee – EAC)	Yes	Large-scale projects with significant environmental impact

Student Notes:

Category B1	State/UT SEIAA (on SEAC recommendation)	Yes	Moderate-scale projects needing detailed scrutiny
Category B2	State/UT SEIAA (on SEAC recommendation)	No	Smaller projects; exempt from detailed EIA

This classification is a **preliminary step** and directly informs the **screening** phase that follows in the EIA process.

EIA thus acts as a preventive tool rather than a corrective one.



4.2. Evolution and Background of EIA in India

EIA originated in **1970** in the **United States**, under the **National Environmental Policy Act (NEPA)**.

- Globalisation and climate treaties (Rio Declaration, UNFCCC) spread the concept globally as a part of **Principle 10** of Rio: Access to information, public participation, and access to justice.

India adopted EIA **formally in 1994**, under the **Environment (Protection) Act, 1986**, following the **Bhopal Gas Tragedy**.

4.2.1. Significance of EIA

The evolution of EIA shows India's increasing attempt to **balance economic growth with environmental protection**. However, the recent attempts at **relaxation of norms under industry pressure** have brought EIA under scrutiny, both domestically and internationally.

The Supreme Court's Key Observations on EIA

EIA as a Climate Safeguard: Essential for sustainable development; acts as a check against unchecked exploitation of natural resources.

- **TN Godavarman Case (1997)**:
  - Recognised **right to a clean environment**.
  - Stressed **mandatory EIA & Environmental Clearance (EC)** before projects, especially in **forest areas**.
- **MC Mehta Case (1996) – Ganga Pollution Case**:
  - Emphasised EIA in projects impacting **water bodies**.
  - Upheld the **citizen's right to pollution-free rivers**.
- **Centre for Environmental Law Case (2018)**:
  - Reaffirmed adherence to **EIA procedures** in development.
  - Highlighted the role of **public consultation** in environmental decision-making

Recent case: The Supreme Court on Retrospective Environmental Clearances: A Landmark May 2025 Verdict: The Supreme Court ruled that **retrospective environmental clearances** (post-facto approvals) are **unconstitutional** and **cannot be granted in the future**.

- Projects **initiated without prior EIA clearance** cannot be legalised later. Violators acting in **deliberate defiance** of the law are **not entitled to protection**.
- The judgement struck down 2021–22 government office memoranda that attempted to regularise such violations.
- Seen as a **boost to environmental rule of law**, the verdict upholds the **right to a clean environment** and aims to close legal loopholes.

However, **concerns remain** about implementation, enforcement, and bypass mechanisms (e.g. land acquisition before clearance), requiring vigilance and legal accountability.

Difference between EIA and SIA

Aspect	EIA (Environmental Impact Assessment)	SIA (Social Impact Assessment)
Focus	Environmental impacts (air, water, land, biodiversity)	Social impacts (livelihood, displacement, culture, rights)
Objective	To mitigate ecological/ environmental harm	To assess and manage impacts on communities and people
Legal Basis (India)	Environment (Protection) Act, 1986	Land Acquisition Act, 2013 (RFCTLARR)
Applicability	Infrastructure, mining, industry, etc.	Projects involving land acquisition/ displacement
Key Stakeholders	Environmental experts, regulatory bodies	Affected communities, local governance, social experts
Outcome	Environmental Clearance with mitigation measures	Social Impact Management Plan & Rehabilitation package
Public Consultation	Mandatory in most cases	Mandatory and detailed for all land acquisition projects

4.3. EIA Notification 2006 vs Draft 2020

Aspect	EIA Notification 2006	Draft EIA 2020
Public Consultation	30 days, mandatory	Reduced to 20 days, diluted role
Post-facto Clearances	Not allowed	Legalised under draft
Monitoring	Bi-annual reports	Once a year
Strategic Projects	Defined and limited	Many broad exemptions—e.g. highways, defence
Role of Public	Community-driven feedback	Marginalised, especially in tribal/remote areas

Controversy & Pushback

- **SC & NGT Rulings (2021–23)**: Rejected post-facto clearance for **LG Polymers (Vizag gas leak)** and affirmed right to a clean environment.

Student Notes:

- **Global Criticism**: UN Special Rapporteurs wrote to Indian government on dilution of public consultation mechanisms.

While the EIA 2006 vs. Draft 2020 debate reveals critical gaps in project-level environmental regulation, it has also underscored the urgent need for a **more anticipatory and landscape-level approach**—enter the concept of *Strategic Environmental Assessment (SEA)*.

4.4. Strategic Environmental Assessment (SEA)

SEA is a **forward-looking planning tool** that applies environmental assessment at the **policy, plan, or programme (PPP)** level—**before individual projects are even conceived**.

4.4.1. Why SEA is important for India?

- India is implementing massive infrastructure programmes (Bharatmala, Sagarmala, Gati Shakti) where **project-level EIA is inadequate**.
- SEA can **prevent ecological fragmentation**, assess **cumulative impacts**, and foster **inter-ministerial coordination** in large-scale planning.
- It has been **recommended by NITI Aayog and the MoEFCC**, though formal adoption remains absent.

4.4.2. EIA and Development Projects

4.4.2.1. Environmental Impacts of Development Projects

Development projects such as large dams, highways, mining ventures, industrial corridors, and power plants have transformed India's landscape, but often at a cost to ecology and social fabric. EIA serves as the primary tool to evaluate these trade-offs.

Key Environmental Concerns:

- **Biodiversity Loss:** Habitat fragmentation due to infrastructure in eco-sensitive zones (e.g., Etalin Hydropower Project in Arunachal Pradesh).
- **Pollution:** Increased air and water pollution from mining and industrial clusters (e.g., Korba, Chhattisgarh – known as India's power capital).
- **Water Stress:** Over-extraction of groundwater and contamination due to chemicals, particularly in semi-arid and drought-prone regions.
- **Climate Impact:** Projects that increase carbon footprint and disturb carbon sinks like forests and wetlands.

Recent Issue (2024-25): The controversy over **Great Nicobar Development Plan**, which included a trans-shipment port, raised concerns over loss of tribal rights and mangrove destruction.

Rehabilitation and Displacement of Human Settlements

Large-scale projects often displace indigenous and rural populations, leading to socio-economic and psychological distress.

Challenges:	**Examples:**	**EIA Limitations:**
• Inadequate compensation • Loss of community networks and traditional livelihoods • Poor implementation of Right to Fair Compensation and Transparency in Land Acquisition Act (2013)	• **Mumbai Coastal Road Project:** Fisherfolk displaced without proper EIA-based livelihood restoration plan. • **Ken-Betwa River Linking Project:** ~20,000 people likely to be affected.	• Often treats displacement superficially. • Public hearings are tokenistic; local consent poorly documented.

Student Notes:

Case Study: Hasdeo Arand Coal Mining

- Adivasi land lost to forests and mines; violations of forest clearance and traditional rights, health risks, and water contamination.
- Local resistance has sparked multiple petitions, with SC yet to give a final judgment

Way Forward

- **Strengthen SEA (Strategic Environmental Assessment):** To go beyond project-level EIA and assess sector-wide and regional impacts.
- **Ensure Participatory EIA:** Involve gram sabhas, especially in Scheduled Areas under PESA Act.
- **Transparent Data Disclosure:** Ensure EIAs and EMPs (Environmental Management Plans) are publicly available in local languages.
- **Monitoring and Compliance:** Shift from one-time clearance to lifecycle monitoring using digital tools like PARIVESH portal.
- **Integrated Livelihood and Ecology Plans:** R&R policies must blend socio-economic restoration with ecological stewardship.

4.5. Governance, Challenges & Stakeholders in EIA

EIA in India is governed by the **Ministry of Environment, Forest and Climate Change (MoEFCC)** under the **Environment Protection Act, 1986**, with regulatory roles shared by State Environment Impact Assessment Authorities (SEIAAs).

- **Decentralisation issues**: While the 2006 notification aimed to devolve power via DEIAAs (district-level), in many states they lack capacity or autonomy, leading to inconsistent implementation.
- **Stakeholders involved**: Regulators (CPCB/SPCBs), project proponents, consultants, affected communities, civil society, and judiciary—all tense in varied roles from oversight to activism.

4.6. Issues with EIA Implementation

Strengths	Challenges Identified
Comprehensive legal framework (EP Act + EIA norms)	**Understaffed regulators**: CPCB with 22% vacant posts; many SPCBs facing >50% vacancies, severely impeding oversight.
Public consultations mandated	**Erosion of public hearings**: Draft 2020 exempts several project categories, including highway and defence projects, reducing stakeholder participation.
Judicial oversight via NGT and Supreme Court	**Ex post facto clearances/SOP loopholes** favored by industry, diluting the integrity of prior EC processes.
Digital filing and transparency (PARIVESH portal)	**Data gaps**: Inaccessible or outdated environmental data hinders credible baseline studies.
Inclusion of SEAC/SEIAA	**Vacancies slow implementation**: DPCC in Delhi filled only 34% positions by May 2025; incomplete recruitment hurts enforcement.

Student Notes:

Role of CPCB & SPCBs: Institutional Backbone of EIA Enforcement

The **Central Pollution Control Board (CPCB)** and **State Pollution Control Boards (SPCBs)** are tasked with ensuring **compliance, monitoring, and enforcement** of post-clearance EIA conditions.

Yet, they suffer from **systemic and capacity constraints**:

- **Vacancies:** Over 50% sanctioned posts remain vacant in many SPCBs; **Bihar and Jharkhand** report over 60% vacancies.
- **Financial inefficiency:** In **Haryana**, only ₹132 crore out of ₹499 crore in pollution penalties were recovered.
- **Budget underutilization:** In 2024–25, just **1% of ₹858 crore** allocated for pollution control was spent.

Role of Environmental NGOs and Activists in Influencing EIA Outcomes

Environmental NGOs (ENGOs) and activists have emerged as critical **non-state actors** in India's environmental governance. Their role in the Environmental Impact Assessment (EIA) process is pivotal, not merely as watchdogs but as **facilitators of participatory democracy**, **information disseminators**, and **legal challengers** to environmentally hazardous projects.

1. **Facilitating Public Awareness and Participation:** Most affected communities lack access to technical EIA reports or understanding of long-term environmental consequences. NGOs bridge this gap by:
   - Translating complex EIA documents into local languages.
   - Mobilizing grassroots participation in public hearings.
   - Filing objections during the **public consultation phase**, influencing the Expert Appraisal Committees (EACs).
2. **Legal Intervention and Advocacy:** NGOs often challenge flawed EIAs in court, especially when:
   - Environmental Clearances (ECs) are granted without proper public consultation.
   - EIA reports are outdated, plagiarised, or deliberately misleading.
3. **Exposing Procedural Flaws and Regulatory Lapses:** ENGOs often scrutinize EIA reports and post-clearance monitoring mechanisms. They expose:
   - Absence of cumulative impact assessments.
   - Violations of conditions post-clearance.
   - Ignoring of ecological sensitivities (e.g., ESZs, CRZ norms).

Environmental NGOs and activists play a **crucial counterbalancing role** in India's EIA regime. Their efforts have not only helped stall ecologically damaging projects but have also brought greater transparency, accountability, and participatory legitimacy to environmental decision-making.

The Indian Himalayan Region needs its own EIA

The Indian Himalayan Region (IHR), vital for India's ecology and water security, faces rising environmental threats.

- **Disasters like Teesta dam breach (Sikkim) and Himachal floods** underscore ecological stress from unsustainable development in IHR.
- IHR is ecologically sensitive, seismically active, and highly vulnerable to **climate change**, yet treated uniformly under existing EIA rules.

Student Notes:

Core Issues with Current EIA in IHR

Issue	Explanation
Uniform Criteria	Same EIA thresholds applied across India, ignoring IHR's terrain, ecology, and vulnerabilities.
Omission from Graded Risk Approach	While critical tiger habitats/National Parks have added scrutiny, IHR lacks separate criteria.
No National Regulator	Despite SC recommendation (Lafarge case), India lacks an independent EIA regulator.
Cumulative Impacts Ignored	EIAs don't assess combined impact of multiple projects in same region.

Way forward

- **Dedicated EIA criteria for IHR** at all 4 stages: screening, scoping, consultation, appraisal.
- Introduce **altitude-based thresholds and general conditions** specific to mountain zones.
- Set up an **independent national environmental regulator** for fair and expert scrutiny.
- Adopt **Strategic Environmental Assessment (SEA)** to assess cumulative regional impacts, especially for linear projects like roads, dams.
- Use **scientific and community-based data** to make EIAs more credible in IHR.

4.7. Benefits vs. Limitations of Environmental Impact Assessment (EIA)

Benefits of EIA	Explanation & Examples	Limitations of EIA	Explanation & Examples
Prevents Environmental Degradation	Helps assess likely ecological impacts before a project begins (e.g., stopping industrial units near ecologically sensitive zones).	**Time-consuming process**	Lengthy procedural delays can hamper urgent infrastructure (e.g., delays in solar park clearances in Rajasthan).
Promotes Environmentally Sound Projects	Ensures sustainability is built into design—e.g., roads through forests require wildlife corridors.	**Limited public participation**	Hearings often superficial, especially in remote/tribal regions—violates spirit of inclusion.
Informs Policy & Decision Makers	Offers scientific basis to approve/reject projects (e.g., Ministry of Environment, Forest & Climate Change often cites EIA reports in clearance decisions).	**Weak post-clearance monitoring**	Once EC is granted, follow-up audits or compliance checks are weak—e.g., Sterlite Plant in Tamil Nadu.
Legal Compliance & Accountability	Helps fulfill environmental legal mandates (e.g.,	**Overemphasis on technical**	EIA reports often overloaded with jargon,

Student Notes:

	Forest Conservation Act, Air & Water Acts).	**data**	making them inaccessible to local communities and grassroots organisations.
Balances Development and Conservation	Enables informed trade-offs between ecological protection and economic need (e.g., Coastal Road project in Mumbai revised to reduce mangrove loss).	**Risk of 'cut-copy-paste' EIA reports**	Generic reports reused across projects—leads to poor site-specific analysis (flagged by NGT multiple times).
Public Consultation Mechanism	Provides communities a voice via public hearings (e.g., protests in Goa against coal hub expansion were informed by EIA data).	**Political & Bureaucratic Pressure**	Influence of project proponents can dilute quality of EIA (e.g., Vizag LG Polymers case with post-facto clearance attempts).
Encourages Inter-agency Coordination	Brings together forest, pollution, water, and energy departments to assess impact holistically.	**Fragmented jurisdictional clarity**	State vs. Centre disputes (e.g., over major irrigation projects like Polavaram) hamper coherent EIA implementation.

5. DISASTER MANAGEMENT

Student Notes:

Previous Year Questions (PYQs)

1. What is disaster resilience? How is it determined? Describe various elements of a resilience framework. Also, mention the global targets of the Sendai Framework for Disaster Risk Reduction (2015–2030). (2024)
2. Flooding in urban areas is an emerging climate-induced disaster. Discuss the causes of this disaster. Mention the features of two such major floods in the last two decades in India. Describe the policies and frameworks in India that aim at tackling such floods. (2024)
3. Dam failures are always catastrophic, especially on the downstream side, resulting in a colossal loss of life and property. Analyze the various causes of dam failures. Give two examples of large dam failures. (2023)
4. The Intergovernmental Panel on Climate Change (IPCC) has predicted a global sea level rise of about one meter by AD 2100. What would be its impact in India and the other countries in the Indian Ocean region? (2023)
5. Explain the mechanism and occurrence of cloudburst in the context of the Indian subcontinent. Discuss two recent examples. (2022)
6. Explain the causes and effects of coastal erosion in India. What are the available coastal management techniques for combating the hazard? (2022)
7. Discuss 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)
8. Describe the various causes and effects of landslides. Mention the important components of the National Landslide Risk Management strategy. (2021)
9. Discuss the recent measures initiated in disaster management by the Government of India departing from the earlier reactive approach. (2020)
10. Disaster preparedness is the first step in any disaster management process. Explain how hazard zonation mapping will help disaster mitigation in the case of landslides. (2019)
11. 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)
12. Describe various measures taken in India for Disaster Risk Reduction (DRR) before and after signing the 'Sendai Framework for DRR (2015-2030)'. How is this framework different from the 'Hyogo Framework for Action, 2005'? (2018)
13. On December 2004, the tsunami brought havoc on 14 countries including India. Discuss the factors responsible for the occurrence of Tsunami and its effects on life and the economy. In the light of guidelines of NDMA (2010), describe the mechanisms for preparedness to reduce the risk during such events. (2017)
14. With reference to National Disaster Management Authority (NDMA) guidelines, discuss the measures to be adopted to mitigate the impact of the recent incidents of cloudbursts in many places of Uttarakhand. (2016)
15. 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)
16. 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)
17. 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)

Student Notes:

18. How important are vulnerability and risk assessment for pre-disaster management? As an administrator, what are the key areas that you would focus on in a Disaster Management System? (2013)

PYQs Analysis

UPSC's disaster-related questions have evolved to test **conceptual clarity**, **practical understanding**, and alignment with **national frameworks and global conventions** like the **Sendai Framework**.

- **Emphasis on Preparedness and Risk Reduction:** Questions from 2013 to 2024 consistently focus on **pre-disaster planning**, **hazard zonation**, and **vulnerability assessment**—shifting the discourse from reactive to proactive disaster governance. Examples: NDMA guidelines on **cloudbursts (2016)**, **earthquake mitigation (2021)**, and **landslide risk strategy (2021)**.
- **Integration of Climate and Urban Risks:** Climate-induced hazards like **urban floods (2016, 2024)**, **coastal erosion (2022)**, and **sea level rise (2023)** reflect a growing UPSC focus on **compound and cascading disasters**, especially in **urban and coastal zones**.
- **Framework-Based Governance:** Increasing references to **NDMA guidelines**, **Sendai vs Hyogo Frameworks (2018)**, and **resilience frameworks (2024)** indicate UPSC's interest in policy literacy and institutional response capacity. The 2020–24 shift highlights India's **systemic transition from response-centric to resilience-centric** disaster management.

5.1. Introduction

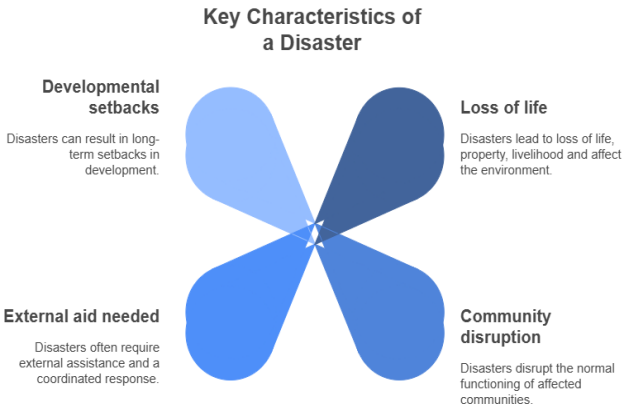
Disasters have been part of human history since ancient times. They reflect the fragile relationship between nature and society. Today, disasters are no longer seen as purely natural events. Human activities, climate change, and unplanned growth have made them more frequent and intense.

Disaster management is not just about responding to emergencies. It is a planned, coordinated effort to reduce risk, build resilience, and protect lives and livelihoods. **For a country like India**, which is prone to both natural and man-made disasters, an effective disaster management system is crucial for achieving sustainable development and ensuring human security.

5.2. Disaster

A **disaster** is a serious disruption in the functioning of a society or community, causing **widespread human, material, economic, or environmental losses** that exceed the ability of the affected population to cope using its own resources.

They occur **when a hazard interacts with vulnerable conditions** — such as poverty, unplanned urbanization, or environmental degradation — turning potential threats into real destruction.



Definition as per the **Disaster Management Act, 2005**

> *"Disaster means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, or by accident or negligence, which results in substantial loss of life or human suffering, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area."*

Student Notes:

Hazard, Vulnerability, and Risk

The impact of a disaster is not determined by the hazard alone. It is shaped by how vulnerable a population is and how exposed they are to that hazard. These three concepts—**hazard**, **vulnerability**, and **risk**—form the conceptual foundation of modern disaster management.

1. Hazard – The Potential Threat

A **hazard** is a **dangerous phenomenon or process** that has the potential to cause loss of life, property damage, social and economic disruption, or environmental degradation.

Types of Hazards:

- **Natural Hazards**: Originating from natural processes of the Earth (e.g., earthquakes, floods, droughts, cyclones)
- **Anthropogenic or Man-made Hazards**: Resulting from human actions or technological failures (e.g., industrial explosions, oil spills, chemical leaks, radiation accidents)
- **Biological Hazards**: Epidemics, pandemics, zoonotic outbreaks (e.g., COVID-19, avian flu)
- **Emerging Hazards**: Cyber attacks, space weather, AI failures

Example: The Chamoli glacier burst in 2021 was a **hydro-geological hazard** with elements of climate-induced change. The Bhopal Gas Tragedy (1984) was a **technological hazard** due to a toxic gas leak from a pesticide plant.

However, a **hazard alone does not become a disaster** unless it affects people, property, or ecosystems.

2. Vulnerability – The Susceptibility to Harm

Vulnerability refers to the **degree to which a population, system, or asset is likely to suffer adverse effects** when exposed to a hazard. It reflects underlying weaknesses or lack of capacity to anticipate, cope with, resist, or recover from the impact.

Dimensions of Vulnerability:

- **Physical vulnerability** – Weak housing, fragile infrastructure, unsafe location (e.g., hill slopes prone to landslides)
- **Social vulnerability** – Age, gender, caste, disability, literacy levels, social exclusion
- **Economic vulnerability** – Poverty, informal livelihoods, lack of savings or insurance
- **Environmental vulnerability** – Degraded ecosystems, deforestation, climate-sensitive zones

Example: During the **2023 flash floods in Himachal Pradesh**, widespread destruction occurred in towns like Mandi, Kullu, and Shimla due to **unregulated construction on unstable hill slopes**, illustrating **high physical and environmental vulnerability**. .

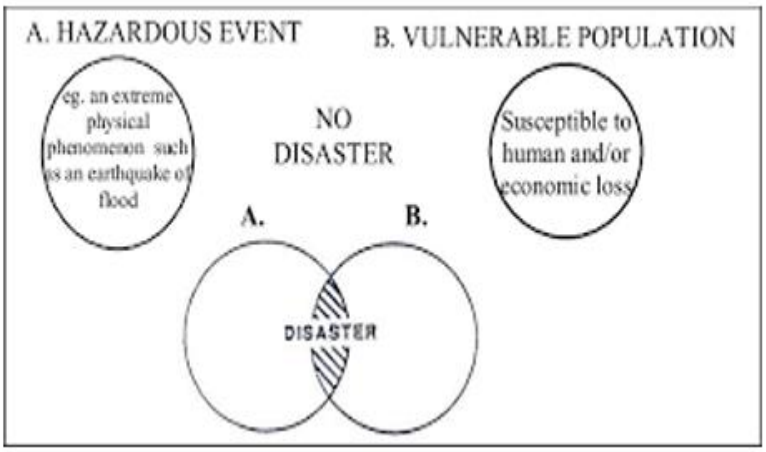
3. Risk – The Likelihood of Harm

Risk is the **probability of harmful consequences** arising from the interaction between hazards and vulnerable conditions. It represents the potential for a disaster to occur.

It is often expressed through the formula:

🔺 **Risk = Hazard × Vulnerability**

Risk = Probability of Hazard x Degree of Vulnerability



Sometimes, **exposure** is added for precision:

🔺 **Disaster Risk = Hazard × Vulnerability × Exposure**

- **Exposure** refers to the **people, infrastructure, housing, and ecosystems** located in hazard-prone areas.
- High exposure increases the chances of damage, even if vulnerability is relatively low.

Example:

In **Sikkim**, the **2023 Glacial Lake Outburst Flood (GLOF)** from South Lhonak Lake caused major destruction downstream. The hazard (GLOF) became a high disaster risk due to **vulnerable infrastructure**, exposed settlements, and **lack of early warning**.

Why This Framework Matters?

This triad—**hazard, vulnerability, and risk**—is the foundation of:

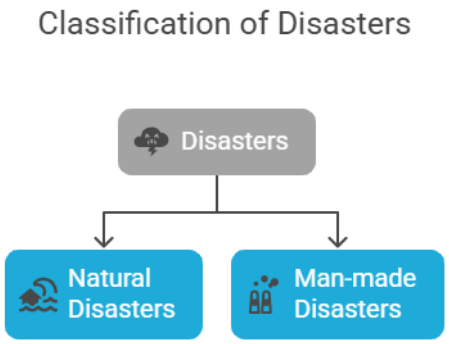
- **Disaster Risk Reduction (DRR)**
- **Hazard Zoning and Risk Mapping**
- **Early Warning Systems**
- **Resilient Development Planning**

It shifts the focus from mere relief and response to **anticipation, mitigation, and risk-informed governance**.

For example: *Sendai Framework for Disaster Risk Reduction (2015–30)* emphasizes understanding risk in all its dimensions—hazard, vulnerability, exposure, capacity, and hazard characteristics.

Student Notes:

5.2.1. Classification of Disasters



Disasters are multifaceted events that differ in origin, intensity, duration, and consequences. For effective planning and management, disasters must be systematically classified.

The classification helps policymakers, administrators, and communities to understand the nature of hazards and adopt tailored mitigation and preparedness strategies.

Broadly, disasters can be classified based on **origin (natural or anthropogenic)**, **causative factors**, and **physical or biological attributes**. The **Disaster Management Act, 2005**, and agencies like **NDMA**, adopt a functional classification that divides disasters into two major categories: **Natural** and **Man-made (Anthropogenic)**.

Natural disasters	Man-made Disasters
They are extreme, sudden events caused by **natural forces or processes of the Earth**. These events are typically beyond human control. Examples: earthquakes, tsunamis, landslides etc.	They are events that result from **human activities, negligence, technological failure, or socio-political factors**. Examples: fires, dam breaches, Stampede etc.

5.2.2. Disaster Management Cycle

Disasters are not isolated events but part of a continuum of phases that occur before, during, and after the disaster strikes.

The **Disaster Management Cycle** represents this continuous and systematic process of planning, preparedness, response, and recovery aimed at minimizing the impact of disasters and ensuring resilient development.

Student Notes:

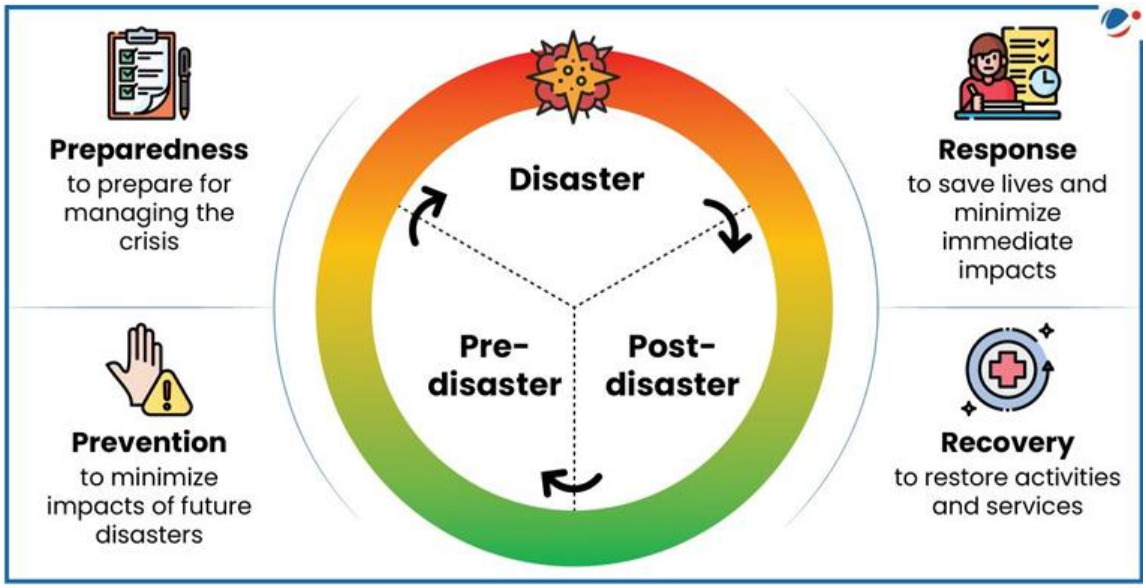
A typical disaster management cycle consists of:

- **A pre-disaster Risk Management Phase** which includes prevention, preparedness. mitigation and
- **Post-disaster Crisis Management Phase** which includes relief, response, reconstruction and recovery.

It is a **holistic framework** that guides governments, institutions, and communities in managing disasters effectively—not just by reacting to them, but by anticipating, preventing, and reducing their impact.

5.2.3. Four Broad Phases of the Disaster Management Cycle

The most widely accepted classification groups disaster management into four interconnected phases:



In the following sections, we will assess each of the three stages of the disaster management cycle in detail.

1. Prevention

Prevention refers to all measures taken to **reduce the impact and severity of future disasters**. It involves both structural and non-structural interventions aimed at minimizing potential damage by either eliminating risks or reducing exposure and vulnerability.

Key Components:

- Hazard mapping and risk zoning (e.g., seismic zoning maps)
- Retrofitting of buildings and infrastructure
- Flood embankments, cyclone shelters, early warning systems
- Policy and regulation (e.g., land-use planning, building codes, coastal regulation zones)
- Environmental conservation (e.g., afforestation, wetland protection)

Prevention is proactive and long-term. It does not prevent the hazard, but limits the potential for disaster by strengthening resilience.

Student Notes:

2. Preparedness

Preparedness involves measures taken **before a disaster strikes** to ensure effective response and recovery. It focuses on building the capacities of governments, institutions, and communities to manage emergency situations.

Key Components:

- Development of disaster management plans (national, state, district levels)
- Training of first responders (e.g., Aapda Mitra volunteers, civil defence, police)
- Conducting mock drills, simulations, and community awareness campaigns
- Stockpiling emergency supplies and equipment
- Development of early warning systems and communication protocols (e.g., CAP-SACHET)

Preparedness bridges the gap between mitigation and response. It ensures that when a disaster occurs, chaos is replaced with coordination.

3. Response

Response includes all actions taken **during and immediately after a disaster** to save lives, reduce health impacts, ensure public safety, and meet the basic subsistence needs of affected populations.

Key Components:

- Search and rescue operations by NDRF, SDRF, armed forces
- Provision of emergency shelter, food, water, and medical aid
- Restoration of critical infrastructure (power, roads, communication)
- Coordinated efforts by central and state agencies, NGOs, and community volunteers
- Emergency health care and psychological support

The efficiency of the response phase often determines the scale of the disaster's human and economic toll. Speed, coordination, and communication are critical here.

4. Recovery and Reconstruction

Recovery refers to efforts made in the **aftermath of a disaster** to restore normalcy and reduce future risk. It is both a short-term and long-term process aimed at rebuilding lives, infrastructure, and systems.

Key Components:

- Damage assessment and compensation
- Restoration of public services and livelihoods
- Reconstruction of housing, schools, health centres, and other infrastructure
- Integration of disaster risk reduction (DRR) and climate resilience into redevelopment
- Psycho-social rehabilitation and community participation in rebuilding

Recovery offers an opportunity to "Build Back Better" — not just to restore what was lost, but to strengthen it against future disasters.

Cycle vs Continuum: A Shift in Approach

Earlier, disaster management was seen as a **linear sequence** of phases. However, modern frameworks view it as a **continuum** where each phase overlaps and informs the next. For instance:

- Preparedness activities are built during recovery.
- Mitigation is mainstreamed into reconstruction.
- Response capacity is enhanced by prior training and planning.

This **cyclical understanding** ensures that disaster management is not reactive but anticipatory, adaptive, and development-linked

Student Notes:

The Disaster Management Cycle transforms disaster handling from reactive relief to proactive resilience. By integrating mitigation, preparedness, response, and recovery into a continuous process, it ensures that societies are not just able to bounce back from disasters, but adapt, transform, and thrive.

What is Disaster Resilience?

Disaster resilience refers to the **capacity of individuals, communities, institutions, and systems** to anticipate, prepare for, withstand, adapt to, and recover from the impacts of disasters, while maintaining essential functions and structures.

It is not just about bouncing back after a disaster but also about **"bouncing forward"**—improving future preparedness, reducing vulnerabilities, and transforming development pathways to minimize future risks.

How is Disaster Resilience Determined?

Disaster resilience is assessed based on the ability to:

- **Anticipate and Prepare for Hazards**: Access to early warning systems, risk information, education.
- **Absorb Shocks**: Robust infrastructure, social safety nets, emergency protocols.
- **Adapt and Transform**: Institutional flexibility, innovation, risk-informed development.
- **Recover Efficiently**: Speed and inclusiveness of post-disaster recovery, community participation, and resource availability.

It varies by **location, socio-economic status, governance capacity, and environmental health**. For example, a coastal village with cyclone shelters and trained volunteers is more resilient than one without them.

5.3. Disaster Management in India

India's geography, climate variability, dense population, and developmental disparities make it one of the most disaster-prone countries in the world. **Approximately 85% of India's area is vulnerable** to one or more hazards such as earthquakes, floods, droughts, cyclones, or industrial accidents.

Over time, India has evolved from a relief-centric approach to a comprehensive, **proactive, and institutionalized disaster risk governance model**, particularly after the enactment of the Disaster Management Act, 2005. The aim is to integrate disaster risk reduction (DRR) with sustainable development.

5.3.1. Legal Framework for Disaster Management in India

India's legal framework for disaster management has undergone a significant transformation over the years — from fragmented relief-based responses to a **codified, institutionalized, and proactive risk governance system**. The shift was crystallized with the enactment of the **Disaster Management Act, 2005**, which serves as the cornerstone of India's disaster governance.

5.3.2. Constitutional Context of Disaster Management

Though the Constitution of India does not explicitly mention "disaster management," it touches upon relevant aspects across various entries:

Seventh Schedule	**Article 21 – Right to Life**	**Article 243G and 243W**
• **Union List**: Defense, Atomic energy, Railways — relevant during CBRN or industrial disasters.	• The **Supreme Court has interpreted Article 21** to include the right to a safe and dignified life,	• Empower **Panchayats and Municipalities** to function as

• **State List**: Public health, land, agriculture — crucial for localized disaster response. • **Concurrent List**: Social security, environment, population control — allows for both central and state intervention.	encompassing protection from disasters (e.g., *M.C. Mehta v. Union of India* on environmental disasters).	institutions of self-government, with authority to implement local disaster plans.

Judicial and Institutional Interventions

- **Supreme Court & High Courts** have played a critical role in enforcing accountability (e.g., *Pradhan Mantri Garib Kalyan Yojana case*, COVID migrant workers case).
- **Comptroller and Auditor General (CAG)** and **Parliamentary Committees** have flagged issues in fund utilization, inter-agency coordination, and absence of mitigation plans.

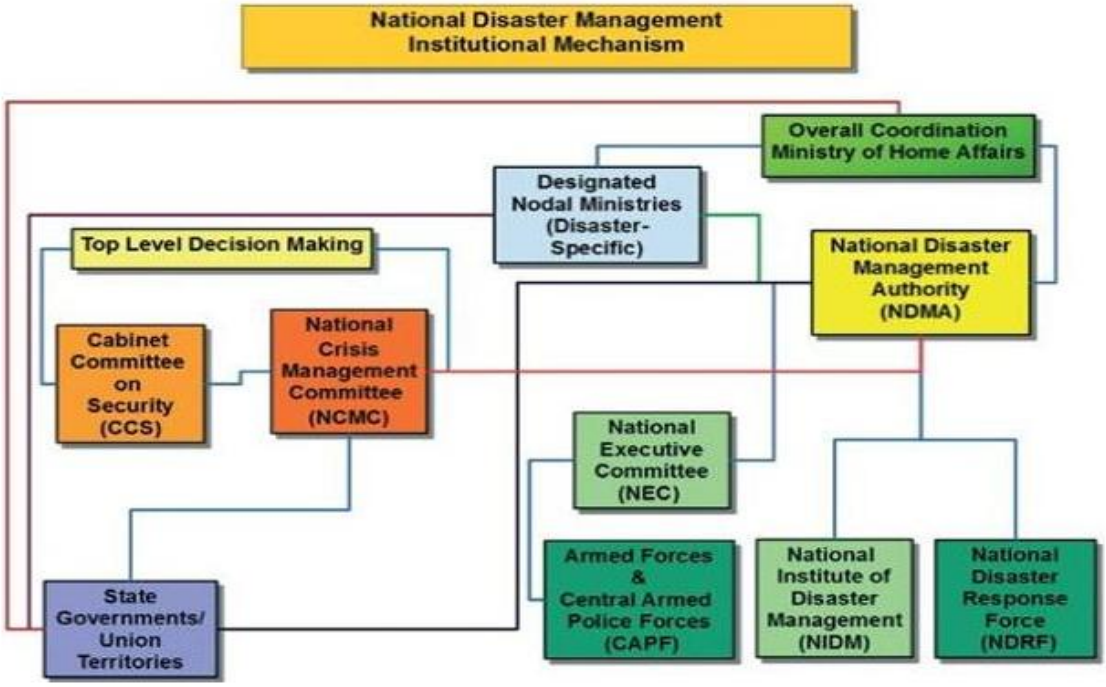
5.3.3. Evolution of Disaster Legislation in India

India's disaster response initially operated without a comprehensive legal framework, primarily relying on **post-disaster relief and rehabilitation**, largely guided by the **Calamity Relief Fund (CRF)** and administrative coordination. Until 2005, responses were event-driven and lacked integration across sectors and stakeholders.

The **2004 Indian Ocean Tsunami**, which exposed serious coordination and planning gaps, acted as a turning point. It led to the formulation and passage of the **Disaster Management Act (DM Act), 2005**, marking a structural shift towards an integrated, multi-stakeholder approach to **disaster risk reduction (DRR).**

5.3.4. Disaster Management Act, 2005

The **Disaster Management Act, 2005** is the first comprehensive legislation in India to address all phases of disaster management — **mitigation, preparedness, response, recovery, and risk reduction** — within a single statutory framework.



Student Notes:

Salient Provisions of the DM Act

- **Three-Tier Institutional Mechanism**
  - **National Disaster Management Authority (NDMA)** – Apex body chaired by the Prime Minister
  - **State Disaster Management Authorities (SDMA)** – Chaired by Chief Ministers
  - **District Disaster Management Authorities (DDMA)** – Headed by District Collectors
- **National Executive Committee (NEC)**
  - Chaired by the Union Home Secretary, tasked with preparing the National Plan and assisting NDMA.
- **Statutory Disaster Management Plans**
  - **National Plan**, **State Plans**, and **District Plans** are mandatory.
  - Must be revised periodically and aligned with the principles of sustainable development.
- **Legal Power to Issue Guidelines**
  - NDMA can issue legally binding guidelines to ministries, states, and departments for DRR.
- **Creation of Dedicated Funds**
  - **National Disaster Response Fund (NDRF)** and **State Disaster Response Fund (SDRF)** for post-disaster relief.
  - **Mitigation Funds** are also provisioned but remain underutilized.
- **National Disaster Response Force (NDRF)**
  - A specialized force with battalions drawn from paramilitary forces, trained for rapid response, especially in CBRN scenarios.
- **Local-Level Involvement**
  - Urban Local Bodies (ULBs), Panchayati Raj Institutions (PRIs), and municipalities are assigned a legal role in preparedness and response at the grassroots level.

Institutional framework at the National Level

At the national level, overall coordination of disaster management vests with the Ministry of Home Affairs (MHA). It coordinates with disaster affected states, line ministries, National Disaster Management Authority (NDMA), National Disaster Response Force (NDRF), National Institute of Disaster Management (NIDM), Home Guards and Civil Defence, and Armed Forces etc.

National Disaster Management Authority (NDMA)

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

- It approves the National Disaster Management Plans and plans of the Central Ministries / Departments.
- The general superintendence, direction, and control of the National Disaster Response Force (NDRF) are vested in and are exercised by the NDMA.
- The National Institute of Disaster Management (NIDM) works within the framework of broad policies and guidelines laid down by the NDM
- NDMA has the power to authorize the Departments or authorities, to make emergency procurement of materials for rescue and relief in a threatening disaster situation or disaster.
- It oversees the provision and application of funds for mitigation and preparedness measures.

Student Notes:

National Executive Committee

Constituted under the DM Act, 2005 and chaired by the **Union Home Secretary** it acts as the **coordinating and monitoring body for disaster management in India**. It also comprises of Secretary level officers from the Ministries and departments having control of agriculture, atomic energy, defence, drinking water supply, environment and forests, finance (expenditure), health, power, rural development, science and technology, space, telecommunications, urban development and water resources.

National Platform for Disaster Risk Reduction (NPDRR)

It is a multi-stakeholder and multi- decision making body on disaster management. It is chaired by the Union Home Minister with other ministers as its members.

- The minister of state in-charge of disaster management in the home ministry and the vice-chairman of the National Disaster Management Authority are the NPDRR's vice chairpersons.

National Disaster Response Force (NDRF)

The NDRF is a specialist response force that can be deployed in a threatening disaster situation or disaster. The general superintendence, direction and control of this force is vested in and exercised by the NDMA and the command and supervision of the Force vests in the Director General of National Disaster Response Force.

- It also has specialist search and rescue teams comprising of engineers, technicians, paramedics and dog squads. The **"proactive availability**" of this Force to the States and its "pre-positioning" in threatening disaster situations has immensely helped minimise damage, caused due to calamities in the country.

Institutional Framework at State Level

State Disaster Management Authority

The DM Act, 2005 mandates the creation of a State Disaster Management Authority with Chief Minister as the ex-officio Chairperson. It is responsible for laying down the State Disaster Management Policy and approve the State DM Plans in accordance with the guidelines laid down by the Union.

It is also responsible for coordinating the implementation of the plan and review the measures being taken for mitigation, capacity building and preparedness by the various state departments.

State Executive Committee

It is responsible for coordinating and monitoring of DM related activities in the state. The Chief Secretary of the state is its ex-officio chairperson. It lays down the guidelines for preparation and implementation of national and state DM plans. It coordinates response in the event of a disaster and gives directions to departments. It is also responsible for promotion of general awareness and community training.

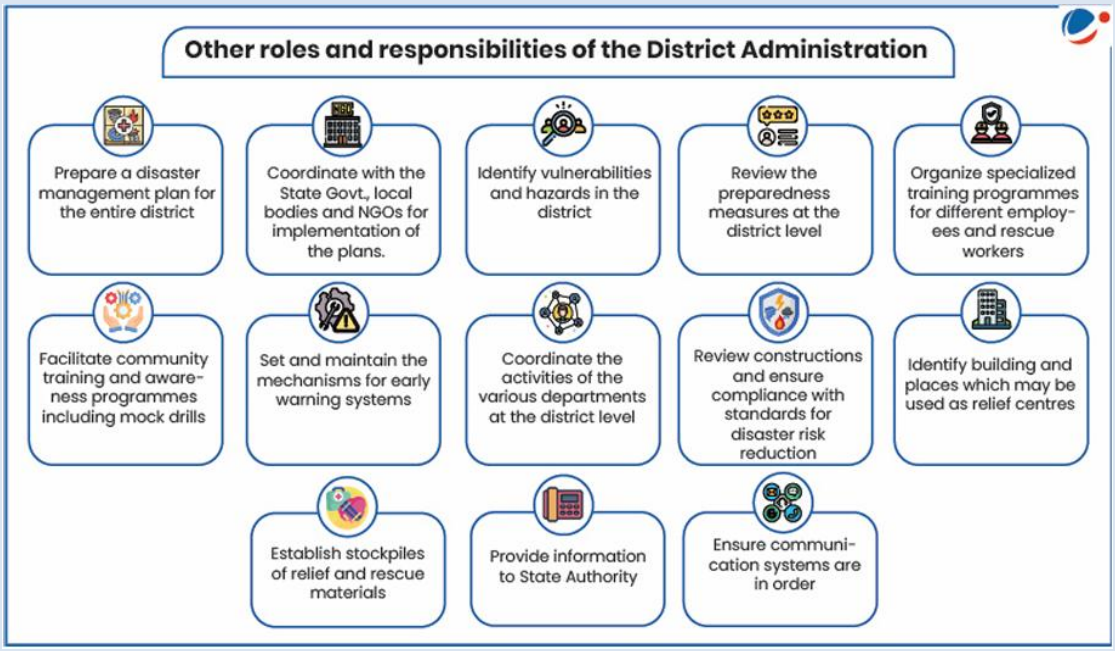
Institutional Framework at the District Level

At the district level, District Disaster Management Authority (DDMA), headed by the District Collector/District Magistrate, is responsible for overall coordination of the disaster management efforts and planning.

- As per provisions of the Act, each State Government establishes a District Disaster Management Authority for every district in the State.

Student Notes:

- The DDMA is headed by the District Collector with the elected representative of the local authority as the Co-Chairperson.
- The DDMA prepares the Disaster Management plan for the District and monitors its implementation. It also ensures that the guidelines laid down by the NDMA and the SDMA are followed by all the district-level offices. Other roles and responsibilities of the District Administration and mentioned in the adjoining infographic.



Local Authorities Panchayati Raj Institutions (PRI), Municipalities, District and Cantonment Boards, and Town Planning Authorities, which control and manage civic services, ensure capacity building of their employees for managing disasters, carrying out relief, rehabilitation and reconstruction activities in the affected areas. They also prepare their disaster management plans as per the national and state guidelines.

Disaster Management (Amendment) Act, 2025

The Disaster Management (Amendment) Act, 2025 marks a significant update to the original 2005 Act in response to evolving disaster risks and governance challenges.

Key Reforms in the Disaster Management (Amendment) Act, 2025

Provision/Change	Description
Expanded Definitions	Introduced definitions of *disaster risk*, *resilience*, *recovery*, *evacuation*, *urban authority*, etc., aligning with global frameworks like SFDRR.
Urban Disaster Management Authorities	All cities with Municipal Corporations (except Delhi & Chandigarh) to have **Urban DM Authorities**, headed by Municipal Commissioners.
Creation of National & State Disaster Databases	Mandates creation of real-time databases for risk, response, mitigation, damage, and relief — critical for planning and audits.
Legal Status to National Crisis Management Committee (NCMC)	NCMC becomes the nodal national coordination body during disasters with serious/national ramifications.

Student Notes:

Mandatory State Disaster Response Force (SDRF)	All states must constitute SDRFs for professional response, mirroring NDRF.
Stronger Role for NDMA	NDMA empowered to give technical guidance, monitor plans, set minimum relief standards, conduct audits, and oversee implementation.

Some Issues that still remains unresolved:

Issue	Explanation
No Upgrade of NDMA's Institutional Status	NDMA still functions under MHA and lacks full **departmental or ministerial autonomy**, hampering proactive functioning.
Persistent Staffing Shortage	The Act doesn't address **member vacancy or recruitment rules** for NDMA; it continues to function with minimal staff.
Funding Framework Remains Centralized	No decentralization of disaster mitigation funds; **fund flow still routed through MoHA**, delaying execution at ground level.
Urban DM Plans are Underdefined	While Urban DM Authorities are created, **no clarity on financial powers, coordination protocols, or tech integration**.
Technology, Climate Linkage Weak	Though emerging risks are acknowledged, **no concrete provisions for integrating AI, GIS, or climate forecasting into local action**.

Student Notes:

5.3.5. Other Laws Complementing the DM Act

Several sectoral and environmental laws support disaster risk reduction:

Law	Relevance
Environment (Protection) Act, 1986	Addresses chemical and ecological disasters
Factories Act, 1948	Worker safety and industrial disaster prevention
The Epidemic Diseases Act, 1897	Legal framework for biological disasters (e.g., COVID-19)
Atomic Energy Act, 1962	For radiological and nuclear emergencies
The Water Act, 1974 & Air Act, 1981	Prevent pollution-induced disasters
Forest (Conservation) Act, 1980	Prevents ecological degradation leading to disasters

Nodal ministries at central level for dealing with different types of disasters:

Disaster	Disaster managed by	Nodal Ministry	Member Ministries of Mitigation Plan Committee
Earthquake	MHA	Ministry of Earth Sciences	Ministries of Science & Technology, Urban Development, Rural Development, Health & Family Welfare, Panchayati Raj, Youth Affairs and sports, Women and Child Development, Human Resource Development, Information & Broadcasting and Departments of Space and IT & Telecommunication
Flood	MHA	Ministry of Water Resources	Departments of Space and Telecommunication
Drought, Hailstorm & Pest Attack	Department of Agriculture & Cooperation, Ministry of Agriculture		-
Landslide	MHA	Ministry of Mines	Ministry of Road Transport and Highways & Shipping
Avalanche	MHA	Ministry of Defence	Ministry of Road Transport and Highways & Shipping
Forest Fire	Ministry of Environment & Forest		-
Nuclear	MHA/ DAE	Department of Atomic Energy (DAE)	Ministries of Defence and Health & Family Welfare
Industrial and Chemical	Ministry of Environment & Forest		-
Biological	Ministry of Health & Family Welfare		Ministries of Defence, Environment & Forests, Agriculture & Co-operation, Animal Husbandry, Dairying & Fisheries; and Chemicals & Fertilizers
Cyclone	MHA	India Meteorological Department	-
Tsunami	MHA	Ministry of Earth Sciences	-
Urban flooding[3]	MHA	Ministry of Urban Development	-

Student Notes:

India's legal and institutional framework for disaster management is one of the most structured in the developing world. However, the **effectiveness lies in execution**, especially at the state and district levels.

Going forward, disaster laws must evolve to account for **compound, cascading, and climate-related risks**, while empowering **local bodies**, enforcing **accountability**, and integrating DRR with **environmental justice and inclusive development**.

5.4. Financial Arrangements under the Disaster Management Act, 2005

India's disaster financing mechanism is governed by the provisions of the **Disaster Management Act, 2005**, which mandates the creation of dedicated funds at both the central and state levels to ensure timely relief, response, and mitigation.

5.4.1. National Disaster Response Fund (NDRF)

- The **NDRF** is managed by the **Central Government** to meet expenses for **emergency response, relief, and rehabilitation** for disasters of severe magnitude.
- If a state's requirement for funds exceeds the available amount in the **State Disaster Response Fund (SDRF)**, the Central Government provides **additional assistance** from the NDRF.
- The **National Calamity Contingency Fund (NCCF)**, created by the 11th Finance Commission, was later **merged with the NDRF**.

5.4.2. State Disaster Response Fund (SDRF)

- The **SDRF** is operated by individual state governments.
- It is meant **only for meeting immediate relief expenditure** for disaster victims.
- It cannot be used for long-term rehabilitation or permanent reconstruction.

Key Observations of the Standing Committee on Finance (2019)(Chairperson: Dr. M. Veerappa Moily)

The Committee submitted a report on **'Central Assistance for Disaster Management and Relief'**, highlighting several critical financial and policy gaps:

1. Scale of Relief

- The **rates and scale of assistance** under both **SDRF and NDRF** should be **enhanced**.
- Assistance should include **restoration of government buildings, power stations, and key infrastructure**.

2. Disaster Mitigation Fund

- The Committee recommended the **operationalisation of a separate Disaster Mitigation Fund**.
- This fund would be used for **permanent mitigation projects**, especially in disaster-prone states.

3. Shrinking Revenue from NCCD

- The **NDRF is funded through the National Calamity Contingency Duty (NCCD)** on certain excise and customs goods.

4. Funding Mechanism

- The Committee suggested that an **additional 10% of allocations** under **centrally sponsored schemes** should be **earmarked for permanent restoration** of damaged assets and infrastructure.

Student Notes:

5. Increase in Corpus of SDRF

- Noting the gap between the **funds demanded by states** and the **funds released by the Centre**, the Committee recommended:
  - An **annual increase of 15%** (instead of the current 5%) in the **SDRF corpus** during the **2020–2025** period.

National Disaster Management Plan – 2019

Updated by the National Disaster Management Authority (NDMA), Ministry of Home Affairs

The **National Disaster Management Plan (NDMP) 2019** is an **updated and expanded version** of India's first national disaster plan (2016).

It reflects the evolving **global and national context** of disaster management and integrates India's commitments to the **Sendai Framework for Disaster Risk Reduction (SFDRR)**, the **Sustainable Development Goals (SDGs)**, and the **Paris Climate Agreement (COP21)**. It also incorporates India's own **Ten-Point Agenda on Disaster Risk Reduction** announced by the Prime Minister.

The NDMP 2019 provides a **comprehensive, coherent, and inclusive framework** for managing disasters in all their dimensions: **prevention, mitigation, preparedness, response, recovery, and building back better**.

Thematic Areas for Disaster Risk Reduction (DRR)

(Aligned with the Sendai Framework and Ten-Point Agenda)

- **Understanding Risk** – Hazard risk and vulnerability assessments, mapping, information systems, data sharing, and monitoring mechanisms.
- **Inter-Agency Coordination** – Strengthening top-level coordination, decentralization of response capacity, and enabling data and warning integration across ministries.
- **Investing in DRR – Structural Measures** – Development of hazard-resistant infrastructure, retrofitting, early warning infrastructure, and resilient lifeline services.
- **Investing in DRR – Non-Structural Measures** – Strengthening of legal, regulatory, institutional, and techno-legal frameworks such as building codes and land-use planning.
- **Capacity Development** – Training, community participation, school safety, awareness, mock drills, and curriculum integration.
- **Climate Change Risk Management** – Inclusion of climate-informed planning, adaptation strategies, and long-term climate resilience integration.

Cross-Cutting Themes Introduced

- **Coherence across Global Frameworks** – Integration of DRR across SDGs, Paris Agreement, and Sendai Framework.
- **Social Inclusion** – Special emphasis on vulnerable groups: women, children, elderly, SC/ST, disabled persons, and sexual minorities.
- **Mainstreaming DRR into Development** – Risk-proofing all policies, investments, and programs at central, state, and local levels.

Structural Features and Time Frame Approach

- NDMP 2019 outlines **short-term (by 2022)**, **medium-term (by 2027)**, and **long-term (by 2030)** objectives in line with global frameworks.
- The plan enables **scalable and flexible implementation** across hazards, geographies, and administrative levels.
- It includes **disaster-specific risk reduction matrices** for over **20 natural and anthropogenic hazards**, including:
  - Thunderstorms, Lightning, Dust Storms, GLOFs, Urban Floods, Heatwaves, Biological and Public Health Emergencies (BPHE), and Forest Fires.

Student Notes:

Response Framework

- Defines the roles of **nodal ministries** and **inter-agency coordination mechanisms** for each hazard.
- **Incident Response Teams (IRTs)** at national, state, district, and sub-district levels are activated as per need.
- **State governments** are the primary responders; the **central government** supplements them with technical, logistical, and financial support.
- A dynamic and regularly updated **Early Warning System** underpins real-time response.

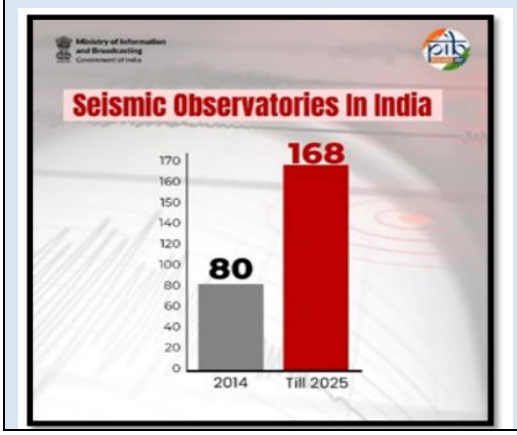
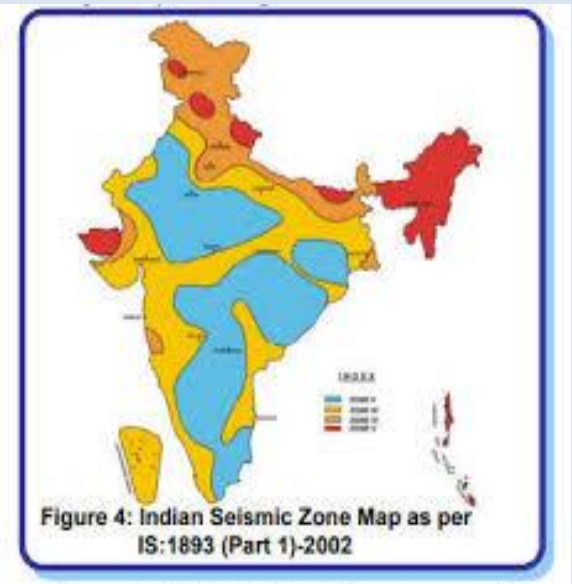
Capacity Development

- Focus on institutional strengthening, training for all levels (PRI/ULB, community, professionals), and strengthening **Disaster Resource Networks**.
- Involves **educational institutions, line departments, civil society, and private sector** for decentralized capacity building.

NDMP 2019 reflects a **mature, globally aligned, and nationally responsive disaster governance model**. It recognizes the **changing nature of risks** — from climate change to biological emergencies — and calls for a **collective, inclusive, and development-linked approach** to disaster risk reduction.

5.5. Major Hazards

5.5.1. Earthquake

Earthquake	Vulnerability Region
An earthquake is defined as the sudden shaking of the Earth's crust. Its impact is sudden, with hardly any warning, **making precise prediction** impossible. • 59% of India is prone to earthquakes. • India recorded **159 earthquakes** from November 2024 to February 2025 	India is divided into four seismic zones, with **Zone V** being the most active. Much of the country lies in **Zone II and Zone III.** 

Mitigation Measures and Government Initiatives in India

Recognizing that earthquakes cannot be prevented or precisely predicted, India focuses on pre-disaster mitigation, preparedness, and vulnerability reduction.

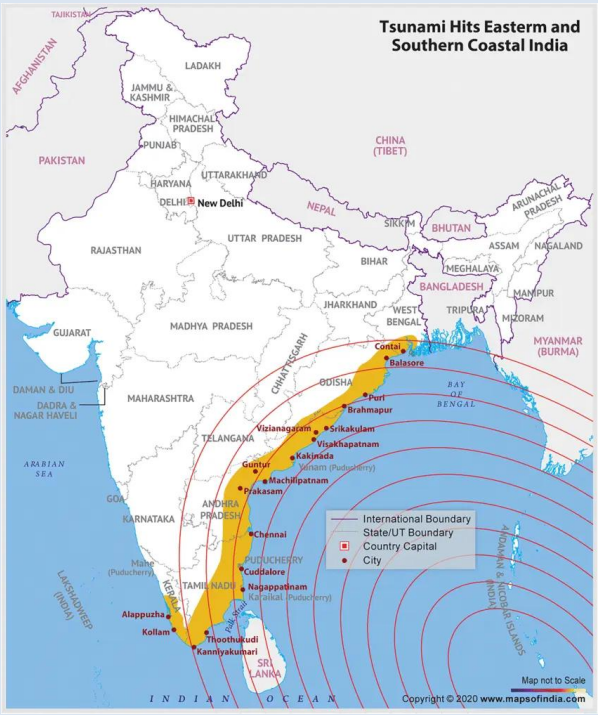
- **National-Level Institutions & Frameworks:**
  - **National Centre for Seismology:** This office under the **Ministry of Earth Sciences** conducts earthquake surveillance and provides hazard reports to government agencies. It also developed the **'India Quake' mobile app** for faster dissemination of earthquake parameters.

Student Notes:

- **National Earthquake Risk Mitigation Project:** Aims to strengthen both structural and non-structural dimensions of earthquake mitigation efforts, focusing on reducing vulnerability in high-risk districts.
- **National Building Code (NBC):** A comprehensive national instrument providing guidelines for **regulating building construction activities** across the country, ensuring structural sufficiency and public safety.

- **NDMA Guidelines on Earthquake Management (Six Pillars):** Guidelines issued by the National Disaster Management Authority (NDMA) provide a strategic framework for seismic safety:
  - **Earthquake Resistant Construction of New Structures:** Facilitating implementation of standards for seismically safe design and construction of new buildings and lifeline structures (bridges, ports).
  - **Selective Seismic Strengthening & Retrofitting:** Developing programs for seismic strengthening of existing priority structures like Raj Bhavans, Legislatures, Courts, and multi-storeyed buildings.
  - **Regulation and Enforcement:** State Governments are responsible for mechanisms to implement **Building Codes** and ensure adherence by all stakeholders (builders, engineers, government departments).
  - **Awareness & Preparedness:** Sensitizing stakeholders through handbooks, safety manuals, video films, and creating vulnerability maps.
  - **Capacity Development:** Education, training, R&D, and capacity building for elected representatives, government officials, professionals, NGOs, and communities.
  - **Emergency Response:** Activities undertaken through an Incident Command System, coordinated by local administration via Emergency Operations Centres.

5.5.2. Tsunami

Tsunami	Vulnerability Region
Tsunami refers to a series of large waves with extremely **long wavelength and period**, typically generated by an undersea disturbance near the coast or in the ocean. 	Though tsunamis are rare in the Indian Ocean, **13 were recorded in the last 300 years**, with 3 in the Andaman and Nicobar region. The **Indian Ocean Tsunami of 26th December 2004** remains one of the most destructive to have hit India, highlighting the extreme vulnerability of low-lying and thickly populated coastal areas.

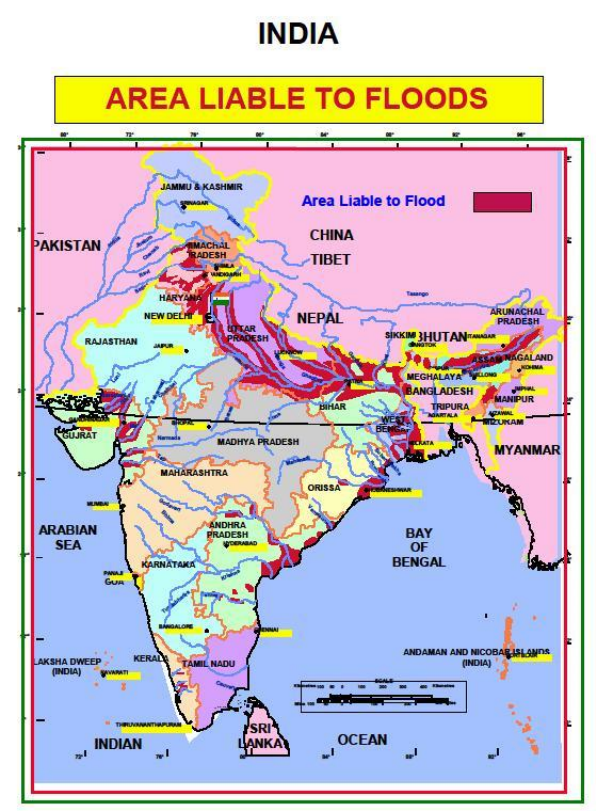
Student Notes:

Mitigation Measures and Government Initiatives in India

Since tsunamis cannot be prevented or accurately predicted, India's strategy focuses on pre-disaster mitigation, preparedness, and preventive measures to reduce vulnerability.

- **NDMA Guidelines on Management of Tsunamis in India (Six Pillars):** The National Disaster Management Authority (NDMA) has issued comprehensive guidelines for **tsunami management:**
  - **Tsunami Risk Assessment & Vulnerability Analysis** focusing on hazard mapping;
  - **Tsunami Preparedness** aiming to establish monitoring networks and awareness campaigns;
  - **Structural Mitigation Measures** recommending natural barriers and built structures;
  - **Regulation & Enforcement of Techno-Legal Regime** emphasizing adherence to safe construction practices;
  - **Emergency Tsunami Response** outlining coordinated search and rescue operations; and
  - **Ensuring Implementation** through capacity building, awareness, and regular drills.
- **Indian Tsunami Early Warning System (ITEWS):** Established collaboratively by the Department of Space, Department of Science and Technology, and CSIR.
  - Capable of detecting Indian Ocean earthquakes in **less than 10 minutes** and provides timely advisories using advanced communication methods, scenario databases, and decision support systems.

5.5.3. Floods

Floods	Vulnerability Region
A flood is a situation when water overflows onto land that is normally dry, causing temporary inundation. **Urban Floods** Urban floods in India have become a pressing issue, disrupting city life and causing economic losses. The World Bank estimates urban flood damage could reach **$1 trillion annually by 2050** globally, with India highly vulnerable due to its urban density. **Main Causes** Research suggests the three main causes of urban floods in India are: • **Inadequate Drainage Systems** • **Encroachment of Natural Water Bodies like lakes and ponds** • **Extreme Rainfall Events**	Around **12% (40 million hectares)** of India's land is prone to floods. The country receives an annual rainfall of 1200 mm, with **85% concentrated in just 3-4 months (June to September)**. This leads to rivers exceeding their carrying capacity. 

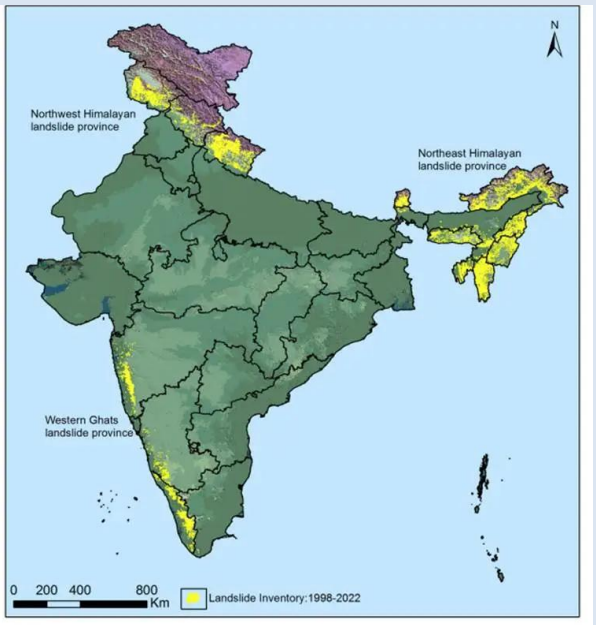
Student Notes:

Mitigation measures

India's flood protection programs primarily rely on **structural measures,** complemented by **non-structural approaches**.

Structural Measures	Non-Structural Measures
Construction of **reservoirs, dams, and other water storages** to hold excess floodwater.	Implementing **Flood Plain Zoning** to regulate land use in flood plains and restrict damage.
Improving drainage systems by restoring their original form, which are often choked by constructions.	Preparing comprehensive **Flood Management Plans** by all government departments and agencies.
Undertaking **channel improvement**, desilting, or dredging of rivers to increase their discharge carrying capacity.	Practicing **Integrated Water Resources Management** at the basin or watershed scale to integrate water resource management.
Implementing **Catchment Area Treatment and Afforestation** to develop vegetative cover and control sudden runoff and flood peaks.	Implementing the **Aapada Mitra Scheme** to train community volunteers in disaster response for immediate relief and rescue tasks during floods.

5.5.4. Landslide

Landslide	Vulnerable Regions
It is a type of "mass wasting," signifying any down-slope movement of soil and rock under the direct influence of gravity. **Primary causes of landslides:** • **Intense and prolonged rainfall**, particularly during the monsoon season (June-September), is the primary trigger for landslides in India. • **Deforestation,** particularly in the Himalayas and Western Ghats, weakens soil structure by removing vegetation that anchors soil. • **Construction of roads, dams, and tunnels** without proper environmental impact assessments destabilizes slopes. • **India's Himalayan region,** formed by the collision of the Indian and Eurasian tectonic plates, experiences continuous stress, rendering rocks friable and prone to landslides.	 Approximately **12.6-15% of India's landmass (0.42 million sq. km)** is prone to landslides, covering the Himalayas, Western Ghats, Northeastern hill ranges, Nilgiris, Eastern Ghats, and Vindhyans.

Landslide Mitigation: NDMA Guidelines

Effective landslide risk reduction involves a **multi-pronged strategy** focusing on prevention and preparedness.

Student Notes:

- **NDMA Guidelines on Landslide Management:**
  - Identifying **hazard zones, stabilizing specific slide areas, and deploying monitoring/early warning systems** at selected sites.
  - Emphasizing **area-specific solutions** and detailed hazard mapping.
  - Enforcing restrictions on construction, road building, and large settlements in **high vulnerability zones**; limiting agriculture to valleys and moderate slopes.
  - **Encouraging large-scale afforestation programs**, construction of bunds to reduce water flow, and building retaining walls on vulnerable slopes.
  - Developing codes for excavation/construction, establishing arrangements for landslide insurance/compensation. Promoting **terrace farming in NE hill states** to replace shifting cultivation.

Avalanche

An avalanche is the rapid descent of a mass of snow, ice, rock, or debris down a mountain slope, triggered by natural or human-induced factors.

Contributing factors:

- Continuous snowfall increases snowpack weight, while weak layers from temperature fluctuations or wind reduce stability.
- Rising temperatures cause freeze-thaw cycles, wetter snow, and glacier melt, increasing avalanche frequency.
- Deforestation for road projects, skiing, snowboarding, and construction (e.g., hydropower plants) destabilize snowpacks.

Mitigation Measures:

Mitigation strategies combine structural, non-structural, and technological approaches:

- **Structural Measures**:
  - **Snow Barriers and Fences**: Installed on slopes to prevent snow buildup or redirect avalanches.
  - **Avalanche Control Piles and Terraces**: Stabilize snow on slopes, with piles spaced ~5 meters apart.
  - **Deflecting Structures and Tunnels**: Protect roads and settlements by redirecting avalanche paths.
- **Non-Structural Measures**:
  - **Artificial Triggering**: Controlled explosions trigger small avalanches to prevent larger ones.
  - **Early Warning Systems**: The India Meteorological Department (IMD) and Snow and Avalanche Study Establishment (SASE) use satellite-based monitoring, remote sensing, and AI models to predict avalanches.
  - **Zoning and Land-Use Planning**: Mapping high-risk areas (e.g., Red, Blue, Yellow Zones) to restrict construction.

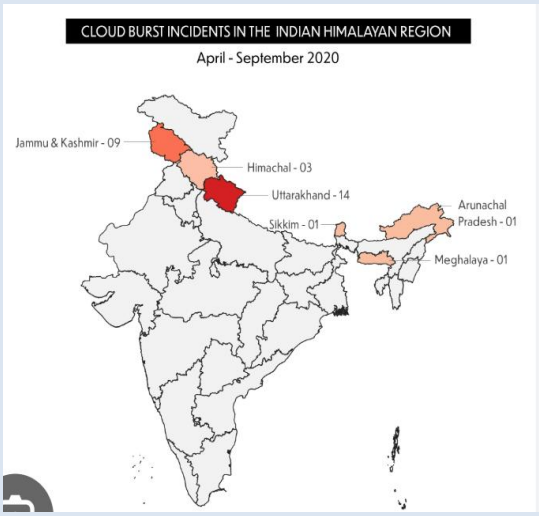
5.5.5. Cloudburst

Cloudburst	Vulnerability region
A cloudburst is a disastrous weather event characterized by extremely heavy rainfall occurring over a localized area at a very fast rate.	Cloudbursts are most common in the Himalayan states (**Jammu & Kashmir, Himachal Pradesh, Uttarakhand)**, but have also been reported on the west coast and in central India during the monsoon season.

Student Notes:

- Specifically, it is classified when rainfall of about **10 cm or above per hour** is recorded over an area roughly **20-30 sq km**.

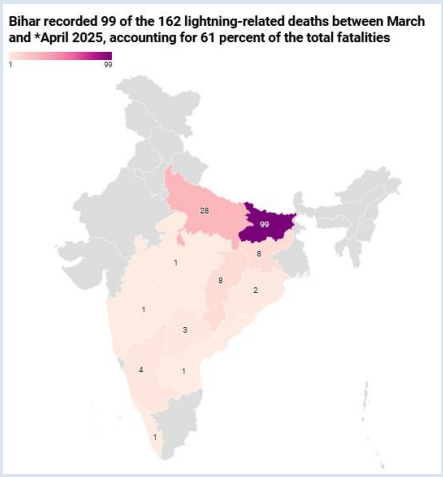
Uttarakhand cloudburst:
In July 2021, Uttarakhand, a northern Indian state, experienced severe cloudbursts across multiple districts, including **Chamoli, Uttarkashi, and Pithoragarh**. These cloudbursts triggered flash floods, landslides, and significant destruction to both infrastructure and lives. The heavy and sudden rainfall caused rivers and streams to overflow, resulting in a swift surge of water downstream.



Mitigation Measures for Cloudburst Risks

- **Safe Settlement**: Advise people to settle on **hard rock** or **firm ground** on slopes, avoiding valleys or abandoned channels prone to flooding.
- **Infiltration Control**: Implement measures to control water **infiltration** in areas with ground fissures or subsidence to prevent further damage.
- **Vigilance and Reporting**: Train local communities to stay **vigilant** and report any changes in slopes or unusual conditions to authorities promptly.
- **Regulating Construction**: Enforce a **ban on unscientific construction**, especially in **landslide-prone areas**, to minimize the risk of instability.
- **Drainage Management and Bioengineering**: Develop effective **rainwater drainage systems**, both surface and sub-surface, and use **bioengineering techniques** with local vegetation to reduce soil erosion and instability.

5.5.6. Lightning

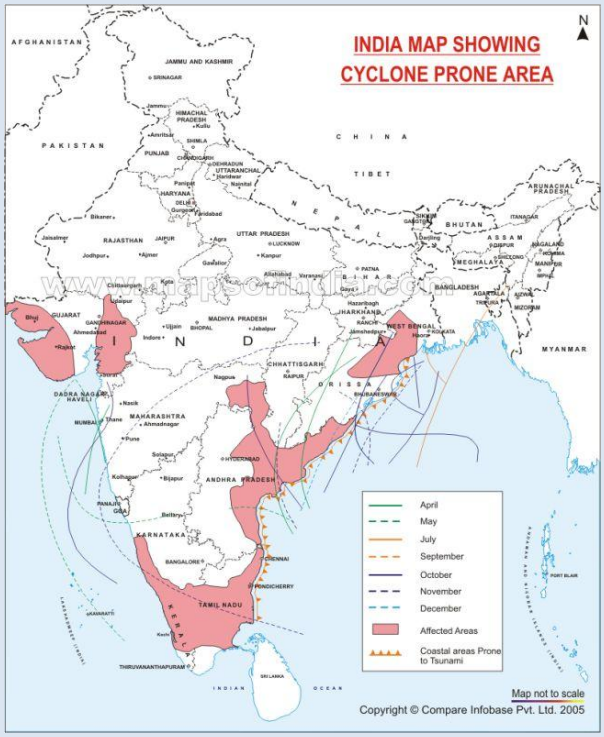
Lightning	Vulnerability
Lightning is a natural phenomenon involving a sudden electrostatic discharge during thunderstorms, causing fatalities, injuries, and property damage.	In March–April 2025, lightning killed over 160 people across 12 states—a 184% increase over the previous year. **Bihar and Uttar Pradesh** were worst affected, with most deaths concentrated in rural areas. 

Student Notes:

Mitigation Measures

- **Early Warning Systems:** India has developed a lightning early warning system, providing forecasts from **five days to three hours** in advance. This system is among only five globally and has proven effective when utilized.
- **Public Awareness Campaigns:** Regular campaigns to educate rural communities about lightning safety (e.g., avoiding open fields, not sheltering under trees) can significantly reduce fatalities.
- **Lightning Action Plans:** States are encouraged to implement lightning action plans, similar to heat action plans, to coordinate preparedness and response.
- **Strengthening Disaster Management:** District authorities should conduct drills and ensure timely dissemination of warnings to communities at risk.
- **Damini App**: Developed by IITM, this mobile app provides location-specific lightning warnings within a 20–40 km radius, valid for 40 minutes. It includes safety tips but struggles with reaching rural farmers without smartphones.

5.5.7. Cyclone

Cyclone	Vulnerability Region
A cyclone is a region of low atmospheric pressure surrounded by **high atmospheric pressure**, resulting in a swirling atmospheric disturbance accompanied by powerful winds.	Over 8,000 km of India's coastline, spanning both **east and west,** faces the hazards of tropical cyclones, storm surges, and heavy rainfall. 

Mitigation Measures and Government Initiatives

India has implemented a multi-sectoral approach to mitigate cyclone risks, guided by comprehensive guidelines and projects.

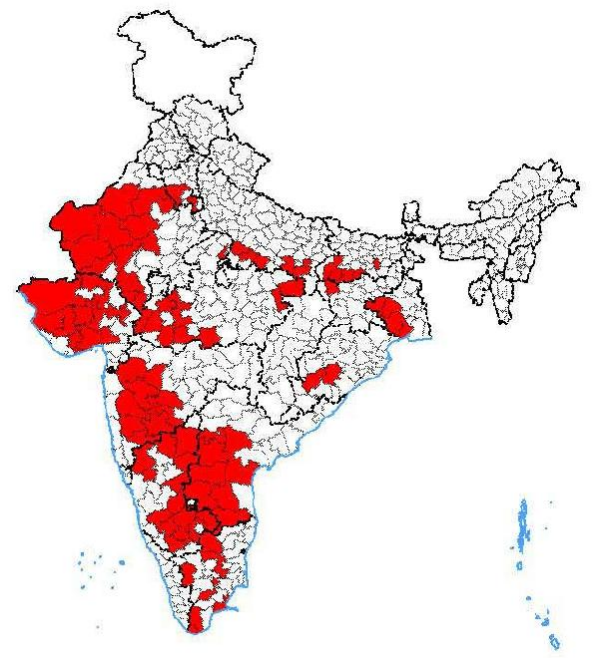
- **NDMA Guidelines on Cyclones (2008):** The National Disaster Management Authority (NDMA) emphasizes multi-sectoral mitigation:
  - **Early Warning System:** IMD operationalizes a satellite-based Cyclone Warning Dissemination System, with warnings provided by Area Cyclone Warning Centers (ACWCs) and Cyclone Warning Centers (CWCs), extensively using Doppler radars.

Student Notes:

- **Aircraft Probing of Cyclone (APC):** Recommended for observing upper air phenomena and understanding the cyclone core environment.
- **Structural Safety:** Ensuring structural safety of **coastal lifeline infrastructure,** constructing multi-purpose cyclone shelters and cattle mounds, and building all-weather roads to shelters.
- **Bio-shields and Embankments:** Constructing saline embankments and coastal bio-shields to prevent saline water ingress during storm surges, and maintaining drain/canal capacity.
- **IMD's Four Colour Codes:** A standardized warning system indicating severity: Green ("all is well"), Yellow ("be aware"), Orange ("be prepared"), and Red ("take action").

- **National Cyclone Risk Mitigation Project (NCRMP):** Initiated by the Government of India, this project aims to undertake suitable **structural and non-structural measures** to mitigate cyclone effects in coastal states and UTs.
  - The project identifies **13 cyclone-prone States and UTs,** categorized by vulnerability (**Category I:** AP, Gujarat, Odisha, Tamil Nadu, West Bengal; **Category II:** Maharashtra, Karnataka, Kerala, Goa, Pondicherry, Lakshadweep, Daman & Diu, Andaman & Nicobar Islands).
  - It is implemented by NDMA/MHA, State Governments, and NIDM, partially funded by the **World Bank.**

5.5.8. Drought

Drought	Vulnerability Regions
Drought refers to a serious shortfall in water availability, primarily due to rain deficiency, affecting **agriculture, drinking water, and industry**. It is a slow-onset disaster, evolving over months or years and impacting vast spatial extents.	Around **68% of India's land is prone to drought** in varying degrees. Over 500 of India's 718 districts report **meteorological drought conditions**, ranging from mildly to extremely dry. 

Mitigation Measures (NDMA Guidelines)

- Create state-level **Drought Monitoring Cells (DMCs)** and control rooms, utilizing ICT for real-time information and vulnerability mapping.
- **Promote watershed development,** use automatic weather stations with **moisture sensors,** and consider a national **cloud seeding policy.**

Student Notes:

- Provide prompt income credit, develop drought insurance, promote short-duration seeds, inter-cropping, mulching, fodder banks, and market intervention for stable fodder prices.
- **Encourage afforestation** with suitable species (e.g., subabul, casurina) and promote biodiesel plantations (e.g., jetropha).
- Formulate **national training and capacity building programs** for drought management, building capacity at PRIs/ULBs.

Drought Prone Area Development programme

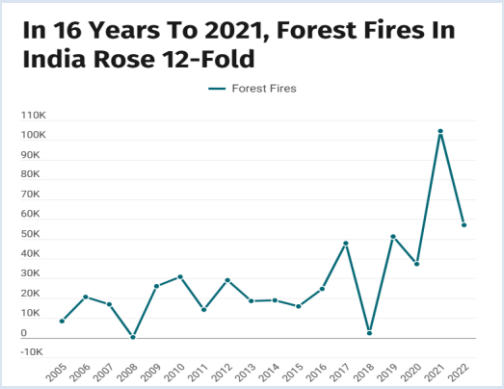
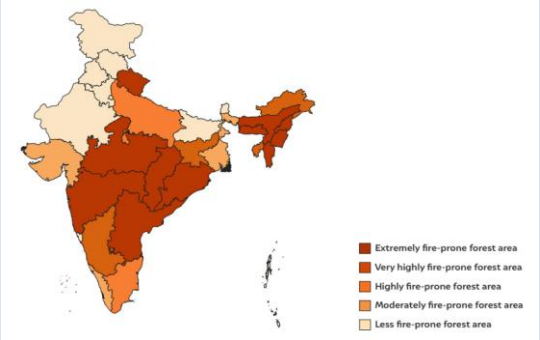
The **Drought Prone Area Development Programme (DPAP)** is a pioneering area development initiative launched by the **Central Government in 1973–74**.

Key features of the DPAP

- **Watershed-Based Approach:** DPAP is implemented through the watershed development model, focusing on **land, water, and vegetation management** to restore ecological balance and promote sustainable resource use.
- **Socio-Economic Development:** The programme seeks to improve the living conditions of resource-poor and disadvantaged communities by **expanding and equitably** distributing the resource base and creating employment opportunities.
- **Integrated Development Activities:** DPAP supports a range of activities such as in-situ soil and moisture **conservation, afforestation, pasture development, and irrigation projects**, all aimed at increasing agricultural productivity and rural infrastructure

Student Notes:

5.5.9. Wildfires

Wildfires	Vulnerability Region
A wildfire is an uncontrolled combustion that consumes large fields and areas of land, often in forests. 	More than **36% of the country's forest cover** has been estimated to be prone to frequent forest fires. Nearly 4 % of the country's forest cover is extremely prone to fire, whereas 6% of forest cover is found to be very highly fire prone. 

Main causes of Wildfires

- **Human Activities:** Deliberate or accidental actions like burning fields for agriculture, discarding lit cigarettes, or leaving campfires unattended spark most fires.
- **Dry Weather Conditions and Climate Change:** Prolonged dry spells, high temperatures, and low humidity, exacerbated by climate change, create ideal fire conditions.
- **Invasive Species and Flammable Vegetation:** Species like lantana camara and pine plantations increase fire risk due to their flammable nature, particularly in dry seasons
- **Poor Forest Management:** Lack of firebreaks, unmaintained forest floors with dry debris, and limited controlled burns contribute to fire spread.

Forest Fires Mitigation in India

Mitigation strategies focus on prevention, early warning, and effective response.

- **National Schemes & Early Warning Systems:**
  - **Forest Fire Prevention & Management Scheme:** A centrally sponsored scheme focusing on prevention through **awareness, improved practices, community participation, and training.** It aims to institutionalize partnerships with forest communities and develop a forecasting system.
  - **Early Warning Systems:** The **FSI's Pre Warning Alert System**, launched in 2016, is an indigenous early warning system based on forest cover, type, climatic variables, and recent fire incidences.
  - **Large Forest Fire Monitoring Programme (2019):** Launched by FSI using near real-time SNPP-VIIRS (**Visible Infrared Imaging Radiometer Suite**) data as part of **FAST 3.0**. This collaborative effort (NASA, ISRO, FSI) sends real-time fire alerts to registered users.
  - **Burnt Area Assessment and Response:** The **Burnt Scar Assessment** involves FSI assessing affected forest areas using high temporal data from **IRS AWiFS (Indian Remote Sensing Advanced Wide Field Sensor)**. This process develops semi-automated methodologies for classifying burnt areas.

Student Notes:

5.5.10. Industrial Disasters

Industrial Disasters	Vulnerability Region/Sector
Industrial hazards are threats to people and life-support systems arising from the mass production of goods and services. **Key industrial disasters** • **Gujarat Factory Fire (2025)**: Fire at a firecracker factory in Banaskantha, Gujarat, killed 21 people due to a boiler explosion, trapping workers inside. • **Thane Chemical Unit Explosion(2024)**: An explosion at a chemical unit in **Thane, Maharashtra**, resulted in 11 deaths, highlighting safety lapses in chemical manufacturing. • **Korba Chimney Collapse (2009):** A chimney under construction at a thermal power plant in **Korba, Chhattisgarh,** collapsed due to poor construction practices, killing 45 workers.	The National Disaster Management Authority (NDMA) highlights **industrial accidents** involving **chemical, biological, and radioactive materials** as significant hazards, underscoring the urgent need for stronger mitigation and preparedness measures. • India has approximately **1861 Major Accident Hazard (MAH)** units spread across 301 districts in 25 states and 3 Union Territories. • These units deal with **hazardous materials,** making them prone to accidents if safety measures are not adequately enforced.
Causes of industrial disasters in India • **Inadequate Safety Regulations and Enforcement**: India has laws like the Factories Act (1948), but overlapping jurisdictions and weak enforcement create loopholes, increasing risks. • **Human Error and Lack of Training**: Untrained workers, often contractual, make mistakes due to fatigue or lack of safety awareness, leading to accidents. • **Poor Maintenance of Equipment**: Neglecting regular checks and repairs, as seen in incidents like the 2019 Visakhapatnam gas leak, causes equipment failures. • **Insufficient Investment in Safety Infrastructure**: Cost-cutting leads to inadequate safety equipment, like poor ventilation, heightening disaster risks.	

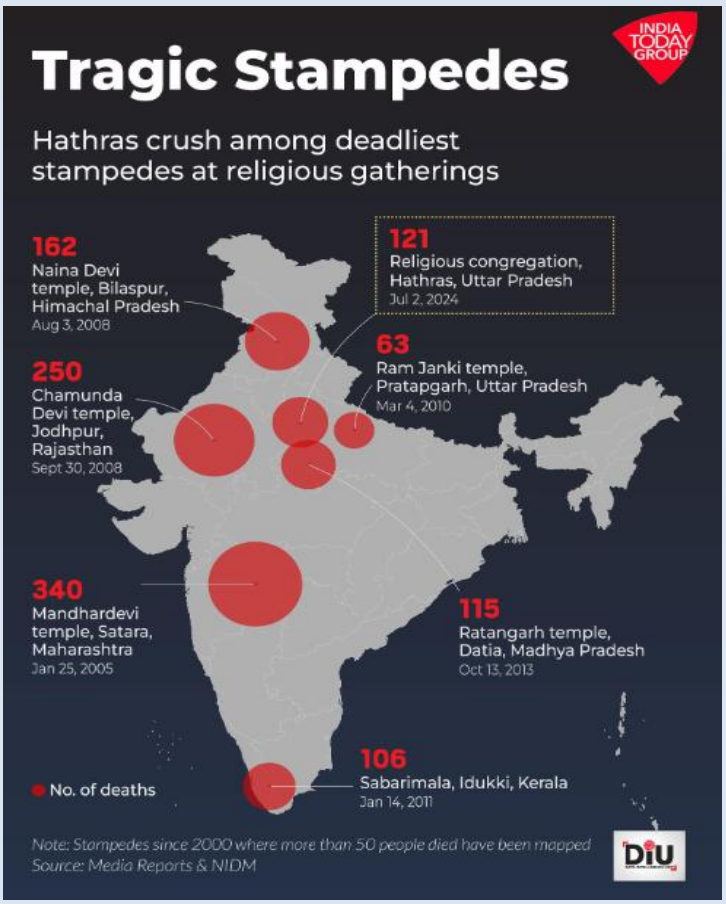
Industrial Disaster Prevention and Mitigation Strategies

Mitigation strategies focus on preventing accidents, minimizing impacts, and ensuring preparedness.

- **Proactive Design & Chemical Lifecycle Management:** Strategies focus on inherently safer designs, proper facility layout, and material selection, including substituting toxic chemicals with safer alternatives and reducing chemical inventory.
- **Robust Process Safety & Audits:** Emphasizes conducting reliability **assessments of process equipment, incorporating safety trips and interlocks**, and fostering a strong safety culture within industrial organizations.
- **Comprehensive Emergency Preparedness:** Involves detailed risk analysis, developing and practicing specific written emergency procedures, and ensuring suitable facilities are in place for both communities and authorities.
- **Safe Transportation & Waste Disposal:** Strategies include arranging special times and escorts for dangerous vehicles to minimize on-road time and ensure public cooperation. It also mandates **proper and safe disposal** of hazardous waste in accordance with existing regulations.
- **Strategic Land Use Planning & Public Awareness:** Requires strict implementation of land use policies, introducing legislation for **buffer zones ('no man's zone)** near industries to **prevent residential encroachmen**t and facilitate relocation of existing colonies.

5.5.11. Stampede

Student Notes:

Stampede	Vulnerability Region/ sector
A stampede is a **deadly and dangerous situation** where a crowd surges beyond the capacity of a space, moving in the same direction, causing people to collide and pile up.	Over **79% of stampedes in India** occur at religious events, where **terrain, infrastructure, and crowd management** are particularly challenging. 

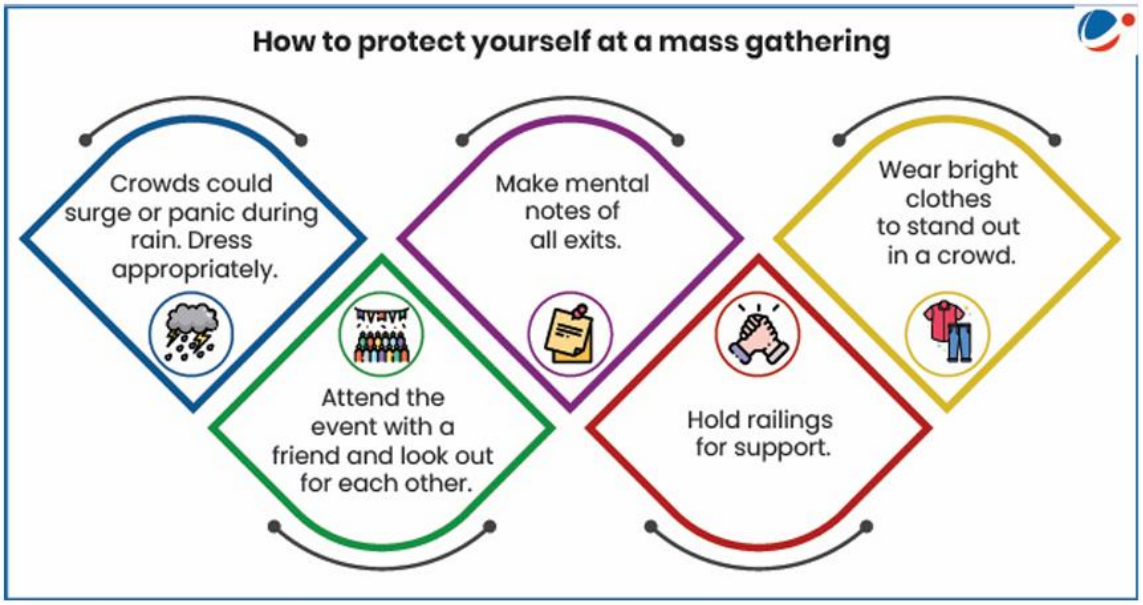
Causes and Contributing Factors of stampede

- **Overcrowding**: Events like the **Maha Kumbh Mela and RCB celebration** saw millions or thousands gathering, exceeding safe capacities.
- **Poor Crowd Management**: Lack of trained personnel and inadequate planning, as seen in the **New Delhi railway station incident**, contributed to panic.
- **Inadequate Infrastructure**: Narrow foot-overbridges, as in the New Delhi case, and slippery steps, as in Mandhardevi, exacerbated risks.
- **Panic Triggers**: Rumors (e.g., bomb threats in 2008) or accidents (e.g., slipping in 2025) often initiate panic, leading to stampedes.

Student Notes:

Crowd Management (Mitigation & Prevention)

Crowd management aims to prevent serious situations from developing through proactive planning and effective response.



- **Risk Management Planning:** The primary goal is to prevent dangerous crowd surges. Venue operators and event organizers develop proactive strategies based on risk assessment.
- **FIST Model (Crowd Behaviour Analysis): Fruin, a renowned theorist,** proposed the **FIST model** to understand crowd behavior and stampede causes.
  - **F:** Crowd Force
  - **I:** Information upon which the crowd acts
  - **S:** Physical Space involved (individual density, architectural features)
  - **T:** Time (duration of the incident)
  - ***Utility****:* This model helps in developing proactive strategies by addressing these four elements during event risk management planning.
- **Governance:** Crowd disaster management is primarily the responsibility of **local organizers and district administration**, supported by state and national authorities.

5.6. Evolution of the Global Framework on Disaster Management

From reactive relief to proactive risk reduction

The global approach to disaster management has evolved significantly over the past five decades — shifting from **post-disaster relief and response** to a more **systematic, proactive, and risk-informed development model**. This transformation has been driven by a series of international frameworks and conferences that helped build a common global understanding of disasters as not merely natural events, but outcomes of risk, vulnerability, and unpreparedness.

1970s–1980s: Relief-Centric and Reactive Approach

Disasters were seen as unavoidable acts of nature. International aid focused on emergency response and humanitarian relief, often led by the Red Cross and UN agencies.

Key Milestone:

- **UN Disaster Relief Coordinator (UNDRO)** was established in 1971 (later evolved into UN OCHA).
- Emphasis remained on **coordination of relief supplies and response**, with limited focus on risk reduction.

Student Notes:

1990s: Recognition of Risk and the Decade of Disaster Reduction

The United Nations designated 1990–2000 as the International Decade for Natural Disaster Reduction (IDNDR). It marked the first attempt to systematically understand disaster risks through science and to reduce vulnerability.

1994: Yokohama Strategy for a Safer World

- Focused on:
  - **Risk identification**
  - **Strengthening early warning systems**
  - **Community involvement**

The Yokohama Strategy laid the foundation for global DRR (Disaster Risk Reduction) as a development concern.

2005: Hyogo Framework for Action (HFA)

World Conference on Disaster Reduction, Kobe, Japan (2005) — just weeks after the Indian Ocean Tsunami (2004).

Key Priorities:

1. Ensure that DRR is a **national and local priority**
2. **Identify, assess and monitor risks**
3. Use **knowledge and education** to build safety and awareness
4. Strengthen **disaster preparedness and response mechanisms**

Significance:

- HFA emphasized **multi-stakeholder engagement**, **institutional capacity**, and **mainstreaming DRR** into all sectors of development.
- India adopted the **Disaster Management Act in 2005**, aligned with Hyogo's priorities.

2015: Sendai Framework for Disaster Risk Reduction (SFDRR)

"From Managing Disasters to Managing Risk"

The **Sendai Framework for Disaster Risk Reduction (SFDRR)** is a landmark global agreement adopted at the **Third United Nations World Conference on Disaster Risk Reduction**, held in **Sendai, Japan**, in **March 2015**. It succeeded the **Hyogo Framework for Action (2005–2015)** and laid the foundation for a **risk-informed, development-centric approach** to disaster management for the next 15 years.

It was the **first major intergovernmental agreement of the post-2015 development agenda**, and it aligns closely with the **Sustainable Development Goals (SDGs)** and the **Paris Climate Agreement**.

Key Shifts Introduced by SFDRR

Hyogo Framework (2005–15)	**Sendai Framework (2015–30)**
Focused on disaster response and resilience	Focus on **risk prevention and reduction**
Emphasized early warning	Emphasized **risk governance and systemic approach**
Targeted institutional preparedness	Targeted **multi-sectoral development integration**
Nation-centric approach	Promotes **local-level ownership and global cooperat**

Student Notes:

Four Priorities for Action

The SFDRR lays out four strategic and interconnected priorities to guide national and international efforts:

1. Understanding Disaster Risk: Improve risk knowledge through **hazard mapping**, **vulnerability assessments**, and **disaggregated data**.

- Promote **risk communication and awareness** at all levels.

2. Strengthening Disaster Risk Governance: Establish clear **roles and responsibilities** across sectors and tiers of government.

- Promote **legal and institutional frameworks** that embed DRR.

3. Investing in Disaster Risk Reduction for Resilience: Allocate **dedicated financial resources** for mitigation, early warning, and resilient infrastructure.

- Promote **eco-DRR**, retrofitting of lifeline infrastructure, and resilient urban planning.

4. Enhancing Disaster Preparedness and Building Back Better: Strengthen **preparedness systems**, early warnings, emergency communication.

- Institutionalize **post-disaster recovery and rehabilitation planning**.
- Promote **Build Back Better (BBB)** — reconstructing safer, greener, and more inclusive systems after a disaster.

Seven Global Targets in the Sendai Framework for Disaster Risk Reduction	
(a)	Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020-2030 compared to the period 2005-2015;
(b)	Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020-2030 compared to the period 2005-2015;
(c)	Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;
(d)	Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;
(e)	Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;
(f)	Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030;
(g)	Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.

India's Alignment with Sendai Framework

India has actively aligned its policies and plans with Sendai through:

- **National Disaster Management Plan (2016 & 2019)** directly structured around the four Sendai priorities.
- Prime Minister's **Ten-Point Agenda on DRR (2016)** emphasizing:
  - Risk-sensitive development
  - Local capacity-building
  - Use of technology and social inclusion
- Launch of **Coalition for Disaster Resilient Infrastructure (CDRI)** in 2019 to globalize resilient infrastructure standards.
- Mainstreaming DRR into **Smart Cities Mission**, **AMRUT**, **Jal Jeevan Mission**, and other flagship schemes.

Student Notes:

The evolution of the global disaster management framework reflects a growing awareness that disasters are not only humanitarian issues but also **developmental, environmental, and governance challenges**.

From reactive relief to proactive risk governance, the global trajectory from Yokohama to Hyogo and Sendai has pushed nations to **mainstream disaster risk reduction across all sectors**, adopt **inclusive and science-based approaches**, and **invest in resilience** as a development priority.

5.7. International Cooperation on Disaster Management

Disasters do not respect political boundaries — their causes and consequences often transcend national jurisdictions. From transboundary floods and pandemics to climate-induced cyclones and earthquakes, the **need for international cooperation in disaster management has never been greater**.

It enables countries to **share knowledge, pool resources, standardize early warning systems, and respond collectively** to crises, especially where national capacities are overwhelmed.

Global and regional institutions, UN agencies, multilateral forums, and bilateral partnerships all play vital roles in this cooperative framework.

5.7.1. United Nations and Multilateral Institutions

United Nations Office for Disaster Risk Reduction (UNDRR) Serves as the global coordinator for the **Sendai Framework for Disaster Risk Reduction (2015–30)**. Supports national governments in risk assessment, planning, and policy alignment. Publishes the **Global Assessment Reports** on disaster risk trends and resilience.	**United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA)** Leads and coordinates international response during major humanitarian disasters. Manages platforms like **ReliefWeb**, and deploys emergency teams under the **UNDAC** system.	**United Nations Development Programme (UNDP)** Provides capacity-building, disaster risk governance support, and technical expertise to over 170 countries.	**World Bank and Global Facility for Disaster Reduction and Recovery (GFDRR)** Provides **financial and technical support** for risk reduction, infrastructure resilience, and disaster insurance systems. Helps countries conduct **Post-Disaster Needs Assessments (PDNA)** and design resilient recovery programs.

5.7.2. Regional and South-South Cooperation

SAARC Disaster Management Centre (SDMC), Gujarat • Coordinates DRR among South Asian nations. • Hosts training, research, and early warning harmonization. • Developed the **SAARC Roadmap on DRR 2016–2030**	**ASEAN Agreement on Disaster Management and Emergency Response (AADMER)** • Promotes regional readiness and joint humanitarian response.	**BIMSTEC and Bay of Bengal Initiatives** • Foster transboundary cooperation in early warning, cyclone tracking, and post-disaster response in the Bay of Bengal.

5.7.3. India's Role in Global Disaster Cooperation

India has emerged as a **regional leader and responsible global actor** in disaster management through its proactive engagement, capacity building, and humanitarian assistance.

Coalition for Disaster Resilient Infrastructure (CDRI)

- A global initiative to promote **climate- and disaster-resilient infrastructure systems**.
- Partners include the UK, Japan, Australia, and several UN bodies.

Coalition for Disaster Resilient Infrastructure (CDRI)

India announced the creation of a Coalition for Disaster Resilient Infrastructure (CDRI) after the Asian Ministerial Conference on Disaster Risk Reduction (2016), held in New Delhi.

- The coalition is working towards developing common standards in infrastructure building, financial and compliance mechanisms and investing in R&D that will also determine funding from multilateral banks onwards for future investments by countries.

Preliminarily, four broad thematic areas have been identified for the work of the coalition. These include:

1. **Disaster Risk Assessment:** It would require good, time-series data on past hazards patterns (e.g. wind speeds, high flood levels) and capability to analyse this data to generate probabilistic risk assessments that can guide investment in disaster resilient infrastructure.
2. **Standards of design & implementation:** The national frameworks for design and construction standards must reflect the evolving understanding of natural hazards as well as advancements in engineering technologies.
3. **Financing new infrastructure and mechanisms for covering risks:** Disaster Risk Financing strategy could include budget reserve funds as well as disaster risk transfer instruments like catastrophic bonds.
4. **Reconstruction and recovery of infrastructure after disasters**: The "Build Back Better" principle must be followed not only for the structural design of the infrastructure but also in terms of management systems around it.

Humanitarian Assistance and Disaster Relief (HADR) Missions

- India has conducted **timely aid missions** in Nepal (2015 earthquake), Maldives, Sri Lanka, Fiji, and Turkey.
- Indian Navy and Air Force play key roles in **rescue and logistics** under "Operation Sahayata" and "Operation Dost".

Bilateral Cooperation

- India collaborates with **Japan, USA, Germany, Australia, and Switzerland** in early warning, seismic research, urban resilience, and flood management.

Technical Assistance and Training

- India offers capacity-building support to **African, ASEAN, and SAARC countries** through:
  - **NIDM training programs**
  - **Space-based disaster support** via ISRO and NRSC

India's approach combines **science diplomacy**, **capacity export**, and **South-South solidarity**.

Way Forward

- Promote **open data sharing**, joint drills, and transboundary early warning systems.
- Strengthen **South-South platforms** and integrate DRR in global development finance.
- Build **localized capacities** in line with global frameworks.
- Institutionalize a **Global Loss and Damage Fund** for climate-linked disasters (as agreed at COP27/COP28).

Student Notes:

Student Notes:

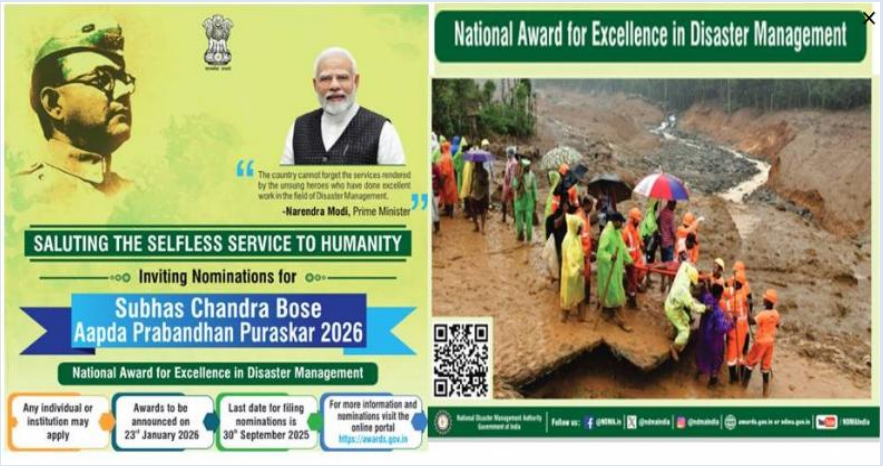
- Enhance regional readiness through **joint emergency command centers** and interoperable protocols.

Disasters are a shared challenge that demand shared solutions. International cooperation enhances **resource mobilization**, **technical capacity**, and **institutional resilience**, especially for developing nations. In a globalized world where disasters are growing in complexity and interconnectedness, **no nation can be disaster-resilient in isolation**. A future-ready disaster management system must be global in vision and local in execution.

5.7.4. Innovative Methods to Save People from Disasters in India

Area	Innovative Action/Tool	Brief Description
Risk Mapping & Technology Tools	**Dynamic Composite Risk Atlas (Web-DCRA)**	Developed for cyclone risk mapping and used during Cyclones Biparjoy and Michaung.
	Flood Hazard Atlas (NRSC)	State-specific flood maps for 12 states, including West Bengal, Bihar, UP, Kerala, and J&K.
	Glacial Lake Dataset	28,000 glacial lakes identified in the Indian Himalayan Region for GLOF preparedness.
	Digital Vulnerability Atlas (BMTPC)	Maps hazard-prone zones to guide construction and planning projects.
Weather Forecasting & Cyclone Tracking	**IMD Monitoring System**	Uses satellites (INSAT 3D/3DR, SCATSAT), radars, buoys, AWS, ARGs for accurate cyclone forecasts.
	IMD Bulletins	Provides timely, precise warnings to all states/UTs.
	Mobile Apps (Damini, Mausam, Meghdoot)	Public-friendly platforms for weather updates, lightning alerts, and agri-weather info.
Early Warning Systems	**National Cyclone Risk Mitigation Project (NCRMP)**	Coastal early warning systems set up in vulnerable states.
	Common Alerting Protocol (CAP) System	Integrated alert system used across India using SMS, sirens, radio, TV, satellite (GAGAN/NavIC), etc.
	SACHET Dashboard + App	Helps disaster managers customize alerts in local languages. 4,500+ crore messages sent.
Emergency Response	**Emergency Response Support System (ERSS) - 112**	A single emergency number for disaster, medical, and law enforcement services.
	NDRF Network	16 battalions and 28 regional centres for rapid response. Conducts rescue, relief, and mock drills.
	Community Awareness	Regular public education and mock exercises by NDRF/NDMA.

Student Notes:

Capacity Building & Education	**IUINDRR-NIDM Network**	330+ universities working on disaster education, research, and curriculum development.
International Leadership	**G20 DRR Working Group**	India created this group with 5 key priorities for global disaster policy.
	Regional Cooperation	Active with SCO, BIMSTEC, IORA — sharing best practices, joint exercises.
	Tsunami Warning Leadership	India's Tsunami Early Warning Centre can now predict wave height and pinpoint buildings at risk in real time.
	Humanitarian Aid Missions	Helped Turkiye & Syria in 2023 earthquake by sending NDRF, medical teams, and supplies under **"Vasudhaiva Kutumbakam".**
Recognition with Awards		

Student Notes:

5.8. Miscellaneous Issues in Disaster Management

Disaster management today is no longer confined to immediate relief and rehabilitation—it has evolved into a complex interplay of social, technological, legal, and ecological dimensions. As disasters grow in frequency and intensity, a range of **emerging but often under-emphasized issues**—such as climate-induced displacement, digital communication dynamics, the role of community institutions, and disaster justice—have come to the forefront.

Climate Change and Disaster-Induced Displacement

- **Rising Displacement**: According to IDMC, **13–23 million people** are displaced globally each year due to disasters; in 2024, India alone saw **5.4 million internal displacements**, mostly due to floods and cyclones.
- **Vulnerable Communities**: Regions like **Assam, Odisha, and Bihar** are experiencing recurrent, climate-induced displacement where people are forced into urban slums, often without legal protection or rehabilitation.
- **Legal Vacuum**: There is **no international legal recognition** for disaster-induced migrants; they are not considered "refugees," which leaves them without formal rights to resettlement or compensation.
- **Emerging Gender and Social Risks**:
  - Women and children face **higher risks of gender-based violence** in temporary shelters.
  - Studies in **Dhemaji (Assam)** show how male migration post-flooding leads to feminization of displacement burdens.

Role of Community in Disaster Management

- **First Responders**: Local communities are the **first to act** after a disaster. Their indigenous knowledge (e.g., flood patterns, cyclone shelters) makes them vital to response.
- **Decentralized Training**:
  - Schemes like **Aapda Mitra** train community volunteers at the district level.
  - Cascading training models empower **panchayats and SHGs** to take charge of local preparedness.
- **School Safety and Public Awareness**:
  - The **School Safety Programme (NDRF)** spreads awareness among children in vulnerable zones.
  - Regular **mock drills** organized by **District Disaster Management Authorities** strengthen coordination and familiarity.
- **Recovery & Psychosocial Support**: Community networks play a critical role in **trauma healing, social rehabilitation**, and restoration of livelihoods post-disaster.

Media and Social Media in Disaster Risk Communication

- **Mainstream Media's Double Role**:
  - Positively: Helps amplify alerts, publicize government relief, and hold authorities accountable.
  - Negatively: Often **sensationalizes** disasters, focusing on emotional imagery rather than accuracy, triggering panic.
- **Digital Media Tools**:
  - Social media platforms (Twitter, Facebook, WhatsApp) enable **real-time, bottom-up communication**.

Role of Education, Research, and Academia

- **Curriculum Integration**:
  - Disaster awareness is now part of the **NCERT curriculum** in Classes 8 to 10.
  - States like Kerala and Gujarat have started teaching **community risk management** in local schools.
- **Research-Policy Link**:
  - The **IUINDRR-NIDM network**, with over **330+ universities**, promotes disaster risk research,

○ During **Cyclone Hudhud**, Visakhapatnam's PWD used WhatsApp groups for resource tracking and team coordination—**bypassing formal red tape**. • **Rumour and Misinformation Threat**: ○ False news can spread rapidly during emergencies (e.g., earthquake panic in Delhi 2023). ○ The **National Alert System (CAP + SACHET dashboard)** is increasingly being used to filter and standardize messages.	policy advisory, and capacity building. ○ Studies on **urban heatwaves, GLOF early warnings**, and **landslide zoning** are being localized through these partnerships. • **Youth Engagement**: ○ Disaster Clubs in colleges, community mapping exercises, and **youth mock drills** are now being promoted in disaster-prone districts.