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1. CLIMATE CHANGE

1.1 United Nations Framework Convention on Climate Change (UNFCCC) COP29

COP29, held in Baku, Azerbaijan, concluded with **Baku Climate Unity Pact**.

Key Outcomes of COP29

- ◆ **New Collective Quantified Goal on Climate Finance (NCQG) or Baku Finance Goal:** Proposed in COP21 for post-2025 climate finance goal under **Article 9** of Paris Agreement.
 - ▶ **Target: Triple finance to USD 300 billion annually by 2035.**
- ◆ **Finalized the rules for Article 6 of Paris Agreement.**
- ◆ Concluded all **transparency negotiating items: Enhanced Transparency Framework (ETF); 1st submissions of Biennial Transparency Reports (BTRs); Baku Declaration on Global Climate Transparency etc.**
- ◆ Launched the **Baku Adaptation Road Map** and **Baku High-Level Dialogue on Adaptation for Framework for Global Climate Resilience** implementation.
 - ▶ Sharm el-Sheikh mitigation Ambition & implementation work programme
- ◆ Adopted **Baku Workplan** and renewed the **mandate of Facilitative Working Group (FWG)** of Local Communities and Indigenous Peoples Platform (LCIPP).
- ◆ 10 year extension to **Lima Work Programme** on Gender & Climate Change.

Key Initiatives/Declarations launched at COP29

- ◆ **Reducing Methane from Organic Waste Declaration** (India not a signatory).
- ◆ **Global Energy Storage and Grids Pledge: 1,500 GW energy storage** in power sector by **2030**.
- ◆ **Hydrogen Declaration: Non-binding Declaration.**
- ◆ **Climate Finance Action Fund (CFAF) (Hq: Baku, Azerbaijan)**
- ◆ **Global Matchmaking Platform (GMP):** Decarbonizing heavy-emitting industries.

Issues persisting in climate negotiations

- ◆ **NCQG falls short of global investment required i.e., \$6.3–6.7 trillion per year by 2030.**
- ◆ **Deadlock on Mitigation Work Programme (MWP)** due to divergent views on **fossil fuels' role in future energy mix** and contention on Global Stocktake.
- ◆ Slow operationalization and inadequate funding in **Loss and Damage Fund (LDF);**

Conclusion

Emission cuts of **42% (by 2030) and 57% (by 2035) below 2019 levels are** needed for 1.5°C. Further, negotiations required **Climate Diplomacy** as per **Common but Differentiated Responsibility**.

1.1.1. India at COP29

India clarified its stance regarding climate negotiation at Plenary Session of **UNFCCC-COP29**.

India's stance on various aspects

- ◆ **NCQG:** Proposed a goal of **\$1.3 trillion annually**.
- ◆ **Opposed changes** to the scope of the **Mitigation Work Programme (MWP)**.
 - ▶ **Recognition of pre-2020 mitigation gap** by developed countries (Annex I).
- ◆ **Just Transition: Developed countries to provide financial/technological support; Respect right to development** of developing countries.
- ◆ Opposed follow-up mechanisms for Global Stock Take (GST) outcomes
- ◆ **Criticized UAE dialogue** text for its lack of connection to finance, etc.
- ◆ Called **for clear indicators to measure progress** on adaptation.
- ◆ Voice of Global South
 - ▶ Integrating **Disaster Resilient Infrastructure into Adaptation Strategies:** By **India** and **Coalition for Disaster Resilient Infrastructure (CDRI)**.

- **Energy Transitions for Global South:** By India and International Solar Alliance (ISA).

Conclusion

India plays a critical leadership role for other **emerging markets** and **developing economies (EMDEs)** in **climate diplomacy**.

1.2 Sea Level Rise

As per the State of Climate 2024, **Global mean sea level rose** at a rate of **4.77 mm annually [2014–23]** (>double between 1993 and 2002).

Trend in India (Centre for Study of Science, Technology and Policy, CSTEP)

- ◆ **Maximum SLR (4.44 cm)** witnessed by Mumbai (1987–2021).

Factors Responsible

- ◆ **Ocean Thermal Expansion:** Absorbing heat from GHGs and **Ice melting:** From glaciers, ice caps, etc.

Impacts of SLR

- ◆ **~32% of India's coastline underwent sea erosion [1990–2018]** (National Centre for Coastal Research (NCCR))
- ◆ **29% of India's population lives within 50 km of coastline** and are vulnerable to displacement.
- ◆ **Freshwater salinization** and Loss of **coastal ecosystems** like mangroves, coral reefs, etc.

Mitigation Measures

- ◆ **Flood Barriers: Ecosystem based** (Oyster beds along the coast); **Man Made** (seawall), etc.
- ◆ **Floating Cities:** E.g., Flood proof cities in **South Korea** and **Maldives**.
- ◆ **Others: Storm surge modelling; Integrated Coastal Zone Management**

Conclusion

Rising sea levels pose a serious threat to India's coastal population and ecosystems. Urgent and integrated mitigation strategies—ranging from natural barriers to innovative infrastructure—are essential to safeguard vulnerable regions and ensure long-term coastal resilience.

1.3 Climate Change Impact on Cryosphere

2025 was designated as the **International Year of Glaciers' Preservation**.

Impacts of Climate Change on Cryosphere

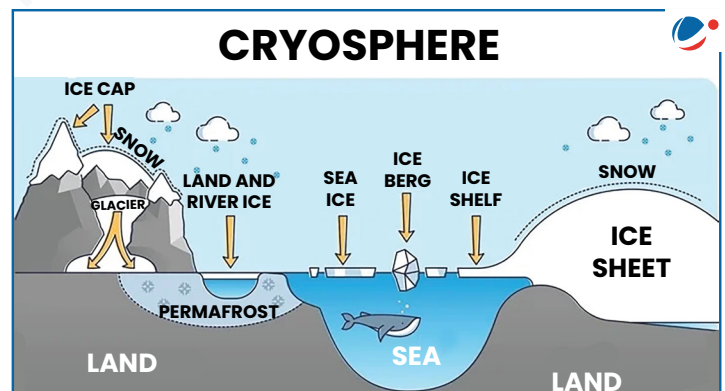
- ◆ **Greenland Ice Sheet** currently losing **30 million tons of ice per hour. (State of Cryosphere 2024)**
- ◆ **Venezuela** lost all its glaciers (2024) and **Nepal's Yala glacier** was declared dead.
- ◆ **Greening of Antarctic**
- ◆ If temperature rises by **2°C**, Himalayas expected to lose **50 % of today's ice**.

Impact of melting Cryosphere

- ◆ **Positive feedback:** Disturbs **Earth Energy Budget** maintained by high Albedo; **Release of Carbon** from Permafrost.
- ◆ **Sea levels:** **60m** rise in global sea level in case all glacier ice melted. (NASA).
- ◆ **Cryosphere stores 80%** of world's fresh water.
- ◆ Weakened **Atlantic Meridional Overturning Circulation (AMOC)** and Slowing of **Antarctic Circumpolar Current (ACC)**
- ◆ Rise in Natural Disasters like **Glacier Lake Outburst Floods (GLOFs)**.

Initiatives

- ◆ **Global: Himalayan Adaptation Network by IUCN; Living Himalayas Initiative** by Worldwide Fund for Nature.



- ◆ **Indian: National Mission for Sustaining the Himalayan Ecosystem; Indian National Centre for Ocean Information Services (INCOIS) etc.**

Way Forward

- ◆ **Integrating** local efforts with international frameworks.
- ◆ **Innovative financial mechanisms through** multilateral development banks (MDBs), private investors, etc.
- ◆ **Others:** Robust data-sharing platforms, policy support, etc.

Conclusion

The rapid melting of the cryosphere due to climate change threatens global sea levels, freshwater reserves, and climate stability. Strengthening global collaboration, local action, and innovative financing is critical to preserving these fragile ecosystems and mitigating cascading impacts.

1.4 Loss and Damage Fund (LDF)

Decisions were made at **COP29** to ensure **full operationalization of LDF**.

About LDF

- ◆ Agreed upon during **COP27** and **operationalized in COP28, Dubai** as an outcome of **Warsaw International Mechanism (WIM)** for Loss and Damage (LD), created in **2013**.
- ◆ **Aim: Total pledged financial support** for Fund has **exceeded \$730 million**.
- ◆ **LD is negative effects of climate change** occurring despite mitigation & adaptation efforts.

Challenges in L&D fund

- ◆ Absence of **a mutually agreed definition** to categorize L&D activities.
- ◆ **Low pledges** in comparison to funding requirement.
- ◆ **Low technical capacity** especially in developing countries – to scientifically model L&D.
- ◆ Difficulty in **quantifying nontangible L&D** like disappearing cultures and ways of living etc.

Way Forward

- ◆ Establishing mechanism to **assess non-economic damage** especially for vulnerable.
- ◆ Account for **losses in ecosystem services and in human productivity**.
- ◆ **Clear criteria for determining contribution levels** and monitoring and enforcing compliance.

Conclusion

LDF upholds **climate justice** by aiding regions with **minimal carbon footprints**.

1.5 Article 6

Rules for carbon trading under Article 6 of the Paris Agreement were finalized.





About Article 6

- ◆ Contains **Tools/mechanisms of carbon market** allowing countries to **voluntarily cooperate** for **Nationally Determined Contribution (NDC)**.
 - ▶ **Carbon Market: Trading systems** where entities **buy carbon credits** to **offset their greenhouse gas emissions** by supporting projects that reduce/remove emissions.
 - ▶ **One tradable carbon credit** generally equals **one metric tonne of carbon dioxide**.
 - ▶ **Types:** Emissions trading system (ETS) and Carbon tax.
- ◆ **3 main mechanisms:** 2 Market-based and 1 Non-market based.
- ◆ **Significance of Article 6: Cut costs for NDCs by >50%**, saving \$250 billion annually by 2030 (World Bank); **Broader Impact** through non-market approaches (Article 6.8), etc.

Mechanisms under Article 6

Market based approaches		Non-Market based approach
Article 6.2	Article 6.4	Article 6.8
<ul style="list-style-type: none"> ◆ Decentralized approach for bilateral cooperation. ◆ Involves trading of International Transferred Mitigation outcomes (ITMOs). 	<ul style="list-style-type: none"> ◆ Centralized approach for transferring ITMOs called Paris Agreement Crediting Mechanism (PACM). ◆ Establishes global carbon market. ◆ Baseline-and-crediting mechanism. 	<ul style="list-style-type: none"> ◆ Promote mitigation and adaptation. ◆ No emission reductions trading. ◆ More than One Participating Party.

Difference between Carbon trading of Kyoto Protocol and Paris Agreement

Aspect	Kyoto Protocol	Paris Agreement (Article 6)
 Scope of Participation	Limited to developed countries (Annex I) with project hosting by developing countries.	Inclusive of all countries.
 Adaptation Funding	Share of proceeds from CDM projects directed to the Adaptation Fund.	5% of proceeds from Article 6.4 transactions allocated to the Global Adaptation Fund.
 Market Scope	Project-based mechanisms like- > Clean Development Mechanism (CDM) and Joint Implementation (JI)	Combines market-based and non-market-based approaches.
 Legacy Credits	Allowed use of older credits from inactive projects, causing oversupply concerns.	Restricts legacy credit use; only post-2013 credits.

Key Challenges

- ◆ **Inadequate Quantification Standards:** Draft rules do not require countries to monitor reversals.
- ◆ **Double Counting:** Article 6.2 do **not strictly avoid inconsistencies in emission reduction calculations**.
- ◆ **Coverage:** Only 24% of global emissions covered under **carbon taxes** and ETS. **(World bank)**

Conclusion

Carbon market requires uniform **reporting standards, third-party verification, and strong safeguards against reversal risks**.

1.6 Carbon Credit Trading Scheme, 2023

Union Environment Ministry notified draft Greenhouse Gases Emission Intensity (GEI) Target Rules, 2025 for **four energy-intensive sectors** (aluminium, cement, chlor-alkali, and pulp & paper) under Carbon Credit Trading Scheme (CCTS), 2023.

Key Highlights of the Rules

- ◆ **GEI Targets Calculation:** As per **Bureau of Energy Efficiency's methodology**.
- ◆ **Compliance for Obligated Entities:** **Meet GEI targets annually** as per CCTS, 2023.
- ◆ **Environmental Compensation:** Imposed by the **Central Pollution Control Board (CPCB)**.
- ◆ **Legal Backing:** Non-compliance under **Environmental Protection Act, 1986**.

About Carbon Credits Trading Scheme (CCTS), 2023

- ◆ Introduced through amendments in **Energy Conservation (Amendment) Act, 2022**, establishes **Indian Carbon Market under two mechanisms**:
 - **Compliance mechanism**: Mandatory program for the energy-intensive industries.
 - ◊ Initially includes 9 sectors like Fertiliser, Iron & Steel, Pulp & Paper, Petrochemicals, etc.
 - **Offset mechanism: Voluntary project-based** for entities not under compliance mechanism.

Challenges of CCTS

- ◆ **Lack of experience** among Industry stakeholders with **complex institutional framework**.
- ◆ **Poor Market Transparency** like **double counting** of GHG reductions, **poor assessment, etc.**
- ◆ Uncertainty about Penalties and **shortage of renewable sources** to meet obligations.

Conclusion

Establishing **clear methodologies for emission targets** for building a transparent, efficient, and globally attractive carbon market in India.

1.7 Green Credit Programme (GCP)

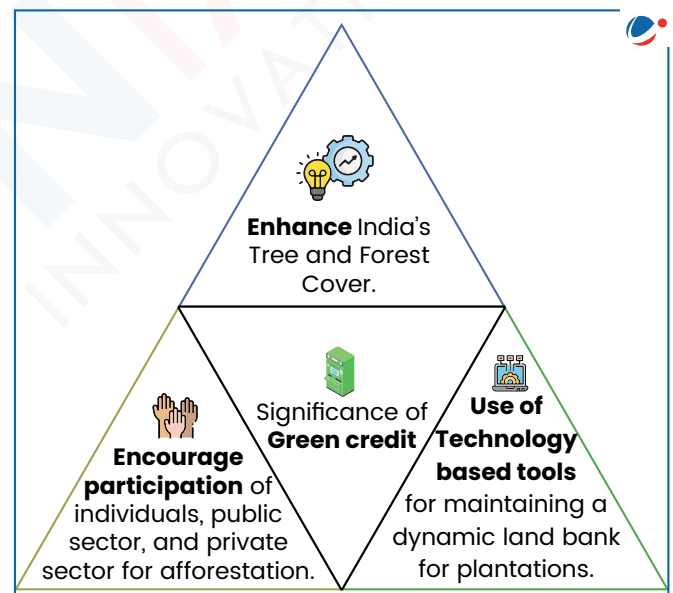
Ministry of Environment, Forests and Climate notified methodology for Calculation of Green Credits (GC) under GCP.

About Green Credit Programme (GCP), 2023

- ◆ Innovative market-based mechanism for **environment positive actions**.
- ◆ **Eligible Activities**: Tree plantations, Sustainable agriculture practices, waste management, etc.
- ◆ **Key Features**: Voluntary Participation, credit trading on domestic platform, etc.
- ◆ **Administering**: Indian Council of Forestry Research and Education (ICFRE), Dehradun.

About Green Credit (GC)

- ◆ Singular incentive unit provided for environmentally positive activity.
- ◆ **Credits can be traded on a dedicated exchange, similar to carbon credits.**



Green Credit	Carbon Credit
Under Environment (Protection) Act, 1986 .	Under Energy Conservation Act, 2001 .
Benefits individuals and communities .	Benefits Industries and corporations .
Green credit activities may qualify for carbon credits , leading to climate co-benefits but not vice versa.	

Concerns Associated with GCP

- ◆ **Incentivizes forest diversion**: Companies can **buy credits instead of restoring forests**.
- ◆ **No addition to forest cover**: Unlike compensatory afforestation, it allows use of **existing degraded forest land**.
- ◆ **Evaluation**: GCP methodology lacks clear criteria for evaluating success.

Way Forward

- ◆ **Establishing the nature and quantified methodology for Green Credit** like carbon credit.
- ◆ **Clearly Defining Activities** to prevent **dual incentivisation** of the same activity.

Conclusion

Though a **promising initiative**, but its success will depend on the **clarity of methodologies and processes implemented**.

1.8 Methane Emissions

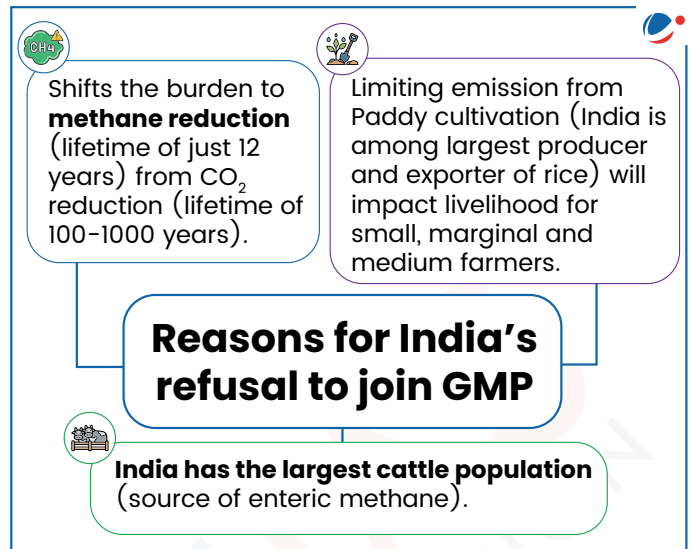
COP29 Presidency launched **Reducing Methane from Organic Waste Declaration** for supporting **2021 Global Methane Pledge (GMP)**.

About Global Methane Pledge (GMP)

- ◆ Launched at **COP26** by the **European Union** and the **USA**.
- ◆ Parties to take **voluntary actions** for **methane emissions** reduction to at least **30% by 2030 from 2020 levels**.

Need for Reducing Methane Emissions

- ◆ **Global Warming Potential (GWP)** 28 times higher than CO_2 .
- ◆ Methane **responsible** for **~30 % global temperature rise** since Industrial Revolution. (Global Methane Tracker, 2025)
- ◆ **Atmospheric methane (CH_4)** saw largest **3-year increase**. (WMO's Greenhouse gas Bulletin))



Initiatives to reduce Methane Emissions

- ◆ **Global:** Earth Surface Mineral Dust Source Investigation (EMIT), Airborne Visible InfraRed Imaging Spectrometer - Next Generation (AVIRIS-NG), etc.
- ◆ **India:** National Mission on Sustainable Agriculture (NMSA), Gobar (Galvanizing Organic Bio-Agro Resources) -Dhan Scheme, etc.

Conclusion

Reducing methane emissions requires global technical and policy efforts, such as international initiatives, improving **livestock feeding practices**, etc.

1.9 Key Concepts in News

1.9.1. Carbon Border Adjustment Mechanism (CBAM)

Kazan Declaration adopted by BRICS rejected CBAM, calling it discriminatory.

About carbon border adjustment mechanism (CBAM)

- ◆ European Union's (EU) policy imposing a **carbon tax** on imports of certain products from countries with less stringent climate policies. **E.g.** Steel.
- ◆ CBAM, **implemented in 2023**, moves from transitional phase to full enforcement by **2026**.

Significance of CBAM

- ◆ **Decarbonisation** of EU.
- ◆ **Prevents Carbon leakage**, when companies in the EU move carbon-intensive production to lenient countries.
- ◆ **Encourage cleaner industrial production** in non-EU countries.

India's Concerns

- ◆ CBAM **tax burden** would represent **0.05% of India's GDP** (Centre for Science and Environment).
- ◆ **Disproportionate burden** on small and medium enterprises (SMEs) compared to larger ones.
- ◆ **Stringent compliance requirements**, certifications, digital filings, and verification protocols.

Conclusion

- ◆ CBAM's climate ambition is noble, but execution is bureaucratically extractive.

1.9.2. Greenwashing

Central Consumer Protection Authority (CCPA) Issues Guidelines for Prevention and Regulation of Greenwashing and Misleading Environmental Claims, 2024.

Key Highlights

- Continuation of the **Guidelines for Prevention of Misleading Advertisement, 2022**.
- Aim to **promote truthful and meaningful environmental claims**.
- Defines Greenwashing as **deceptive or misleading practices**, including misleading words, symbols, or imagery.
- Applicable to **all environmental claims, manufacturers, etc.**

Types of Greenwashing

- Greenhushing** (underreporting/hiding sustainable credentials)
- Greenrinsing** (regular changing of ESG targets before achievement)
- Greenlabeling** (labelling unsustainable product as green); etc.

Need for Regulating Green Washing

- Prevent erosion of public trust:** E.g., in Volkswagen emissions scandal (2015),
- Delay genuine solutions** to climate change
- Redirect resources** towards environmental friendliness.

Conclusion

The guidelines could be enhanced with **new technologies like AI** for accountability and cross-border collaboration.

1.9.3. Carbon Capture and Utilisation (CCU)

India Unveiled First Cluster of Five CCU Testbeds for Cement Sector.

About Carbon Capture and Utilisation (CCU)

- Technologies for **capture & use of carbon as a feedstock** to make products like fuels, chemicals, etc.
- Carbon Capture:**
 - From industrial or energy sources:** Technologies like membranes, solvent absorption, etc.
 - Directly from the air (Direct Air Capture - DAC):** Through a gas trapping system where CO₂ is isolated from the rest of the air.
- Carbon Utilisation:** Once captured, CO₂ can go for Direct Utilisation or CO₂-to-Products (**See image**)

Significance of CCUS

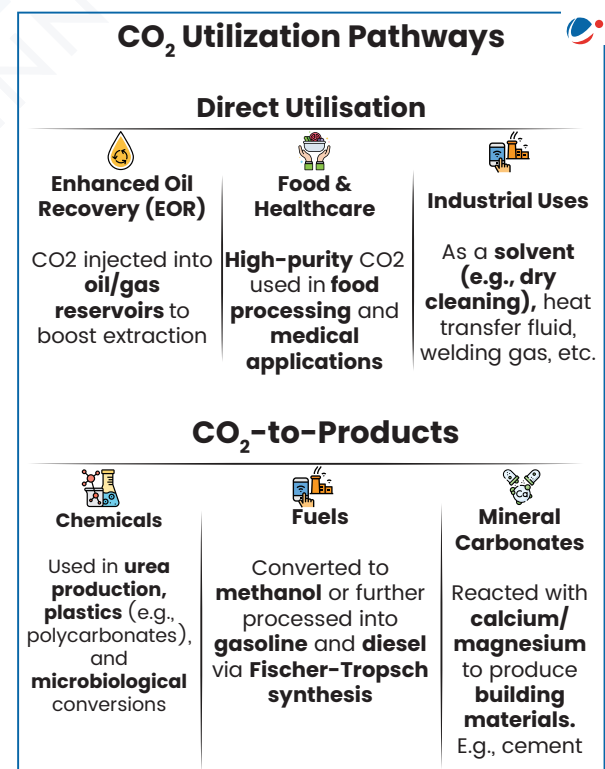
- Decarbonisation of Hard to abate sectors:** Like cement, steel, etc.
- Propel Low carbon Hydrogen**
- Realization of Net Zero Targets**

Issues with CCUS adoption in India

- Variation in Carbon Capture Costs across sectors.**
- Limited CO₂ storage Limit**, especially for saline aquifers and basaltic storage.
- Absence of downstream CO₂ infrastructure.**

Conclusion

Despite **high costs, regulatory complexities**, CCUS is a critical technology for **decarbonization**.





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2. ENVIRONMENTAL POLLUTION AND DEGRADATION

2.1 Coal Thermal Power Plants (TPPs)

MoEF&CC has granted a **fourth extension** for coal-based **TPPs** to comply with **SO₂ emission norms**.

◆ In **2015**, India introduced its **first emission norms** for TPPs targeting **SO₂, NO₂, and Mercury**, aiming to curb air pollution caused by coal combustion.

Major Pollutants from Coal-Based TPPs

◆ **GHGs: Carbon Dioxide (CO₂), Sulphur Dioxide (SO₂), Nitrogen Oxides (NO₂)**

▸ Decarbonizing coal-based power can cut India's GHG emissions by **30%**.

◆ **Particulate Matter: Fly Ash, PM2.5, PM10.**

◆ **Other:** Heavy metals like Mercury and bottom ash.

Why Coal Still Matters

◆ **Energy security:** Meets ~55% of India's power needs.

▸ Electricity use may triple by 2050 (IEA).

◆ **Domestic availability:** 5th largest coal reserves globally.

◆ **Employment & regional development** in mining areas (e.g., Jharkhand, Odisha).

Emission Control Measures

◆ **Flue Gas De-sulphurisation (FGD) Technology, Electro Static Precipitator (ESP), NO_x Combustion Modification etc.**

◆ **Perform, Achieve, Trade (PAT) Scheme.**

◆ **Biomass co-firing** to reduce net emissions.

◆ Promotion of **efficient Ultra Supercritical/Supercritical units over Subcritical Thermal Units**

◆ **Carbon capture pilot** at Vindhyachal.

Conclusion

Mitigating pollution from coal use requires promoting reuse and recycling of coal combustion by-products and fuel cleaning methods like coal beneficiation and washing

2.2 Water (Prevention and Control of Pollution) Amendment Act, 2024

MoEF&CC notified new rules for **holding inquiry and imposing penalties**, following the decriminalization of offences under the Water Act, **replacing them with penalties**.

Key Features of the Original Act (1974)

◆ Aims to prevent, control, and restore water quality in India.

◆ Establishes **Central Pollution Control Boards (CPCB)** and **State Pollution Control Boards (SPCB)** as regulatory bodies.

◆ Requires industrial units to obtain consent from SPCBs before operations.

Key Amendments (2024)

◆ **Central government empowered to-**

▸ **Prescribe** manner of nomination and terms and conditions of service of **Chairman of SPCB**

▸ **Exempt certain categories of industrial plants** from restrictions on **new outlets and discharges**.

▸ **Issue guidelines** for grant, refusal, or cancellation of consent granted by SPCB.

◆ Head of a department liable **to pay penalty equal to one month of their basic salary** if department violates any provision.

◆ **Allows to Appoint Adjudicating officer** to determine penalties

- Penalties to be **credited to the Environment Protection Fund** established under the **Environment (Protection) Act, 1986**.

Significance of Amendments



Decriminalization for **Trust-Based Governance** and **ease of living** and business operations



Reduced **Regulatory Burden**



Streamlined Appointment Processes



Balancing Development and **Environment Protection**

Conclusion

Stakeholder Engagement and training and capacity-building programs for Pollution Control Boards can enhance effective enforcement of environmental regulations

2.3 Community Participation in Water Conservation

Recently, **Jal Sanchay Jan Bhagidari** initiative was launched by Ministry of Jal Shakti from Surat, Gujarat.

About Jal Sanchay Jan Bhagidari initiative

- ◆ Inspired by **Gujarat's successful Jal Sanchay initiative**, it focuses on **water conservation through community participation**.

Significance of Community Participation in Water Conservation

- ◆ **Foster Behavioural response:** E.g., **Jal Sahelis** in **Bundelkhand** have sparked a cultural shift towards Conservation.
- ◆ **Utilization of Local Knowledge and Insights:** E.g., **Bari Farming System (Assam)** involves co-existence of fruit trees, vegetable cultivations, and the pond.
- ◆ **Instilling a sense of ownership:** **Pani Panchayat, Odisha** involves voluntary farmers' participation in distribution of surface and ground water.

Challenges

- ◆ **Lack of accessibility and complexity** of water resources data
- ◆ **Limited technical knowledge** required for water conservation.
- ◆ **Limited association with outsiders** and Mere Ceremonial Involvement: E.g. At Panchayat level.

Conclusion

Promoting participative water conservation requires **inclusive policy dialogue, active involvement of corporate and community stakeholders**, and the adoption of sustainable practices like **LIFE**.



2.4 Ground Water Pollution in India

Union Minister of Jal Shakti released **Annual Ground Water Quality Report** of the Country for the Year 2024.

About Groundwater pollution

- ◆ **Major Groundwater Contaminants:** Nitrate (e.g. Rajasthan), Fluoride (e.g. Rajasthan), Arsenic (e.g. West Bengal), Uranium (e.g. Rajasthan) and Salinity (e.g. Delhi)
- ◆ **Major Causes:** Discharge of untreated industrial waste; Excessive fertilizers and pesticides use; Climate Change Impact and overuse on GW levels

Initiatives

- ◆ **Legislative provisions:** Water (Prevention and Control of Pollution) Act 1974, Environment Protection Act 1986 and The Water Cess Act, 1977.

- ◆ **Institutional:** Central Ground Water Authority; Central Ground Water Board (CGWB); Central Pollution Control Board.

Way Forward

- ◆ Separate **groundwater rights from land ownership** & empower local bodies for regulation.
- ◆ **Phytoremediation:** E.g. using aquatic plants to accumulate and remove arsenic from GW.
- ◆ Prevent **overuse of nitrogenous fertilizers** in agriculture.

Conclusion

Groundwater pollution in India remains a serious concern. Strengthening local regulation, curbing fertilizer overuse, and adopting eco-friendly solutions like phytoremediation are key to safeguarding this vital resource.

2.5 Water Recycling & Reuse in India

'Jal hi Amrit' initiative under AMRUT2.0 was launched to **incentivize States /UTs** for efficient management of **Sewage Treatment Plants (STPs)/Used Water Treatment Plants (UWTPS)**.

Water Recycling & Reuse in India

- ◆ ~72% of India's wastewater ends up in nearby rivers, lakes, etc. (Centre for Science and Environment (CSE))

Water Reuse Technologies

- ◆ Membrane Bioreactor; Ultrafiltration; Reverse Osmosis and Disinfection Technologies (UV/Ozone/Advanced Oxidation); Electrodialysis Reversal; Thermal Evaporation/ Crystallization etc.

Challenges of Water Recycling & Reuse

- ◆ **Low treatment capacity of Sewage treatment plants (STPs):** ~18.6% in Class I cities and Class II towns
- ◆ **High Capital and Operational Costs of STPs**
- ◆ **Low Compliance rate of STPs: 23 % of treatment capacity** is meeting the consented parameters of State Pollution Control Boards (SPCBs)
- ◆ **Lack of specific framework** for treatment of polluted water

Initiatives

- ◆ National Framework on Safe Reuse of Treated Water in 2022.
- ◆ **Power Tariff Policy 2016:** Mandates all Thermal Power Plants to use treated sewage water
- ◆ **National Water Policy-2012** mandates recycle and reuse of water

Way Forward

- ◆ **Decentralized STPs at city-level** E.g. Bangalore's district split into 3 zones based on its natural topography
- ◆ **Governance reforms** E.g., Karnataka, ULBs has defined responsibilities
- ◆ **Implement tiered volumetric pricing structure**
- ◆ **Implement tradable water-use credits system** based on treated wastewater usage.

Conclusion

India must overcome infrastructural and regulatory gaps to scale water recycling, with decentralization and market-based incentives offering viable pathways forward.

2.6 Plastic Pollution




Recently Plastic Pollution Treaty Negotiations were adjourned in Busan, South Korea **without finalization of a treaty**.

About the Plastic Pollution Treaty

- ◆ Mandated by a **2022 UN Environment Assembly resolution**.
- ◆ **India's stance on Plastic Pollution Treaty**
 - ▶ **Inability to support** any measures to regulate the production of primary plastic polymers as it could impact development rights of nations.
 - ▶ **Scope of instrument to be limited to addressing plastic pollution only.**
 - ▶ **No support to inclusion of any list with phase out dates**, at this stage.

- Need of **due consideration to national circumstances and capabilities**

Plastic Pollution in India

Status of Plastic Pollution in India	
 4.12 Million Tonnes Per Annum plastic waste is generated. (CPCB's annual report in 2020-21)	 Per capita plastic waste generation doubled over last 5 years. (CPCB's annual report in 2020-21)
 Ranked 3rd globally in generation of single-use plastic (SUP) waste (Plastic Waste Makers Index 2019)	

Challenges in tackling Plastic waste in India (Public Accounts Committee (PAC) report titled “**Pollution caused by Plastic**”)

- ◆ **Absence of mechanism for assessment** of generation of plastic wastes.
- ◆ **Non-Compliance like** non-registration of plastic units, etc.
- ◆ **Units functioning without valid registration** due to lackadaisical approach of CPCB, SPCBs, etc.
- ◆ **Delay in elimination of Single Use Plastic (SUP)** as many states did not ban it.

Initiatives taken for Tackling Plastic Pollution in India

- ◆ Plastic Waste Management Rules and its amendment
- ◆ Plastic Waste Management (Amendment) Rules, 2024
 - **Responsibility of Producers, Importers and Brand Owners** for collection of such plastic packaging
- ◆ Extended Producer Responsibility on Plastic Packaging, 2022
- ◆ **Project REPLAN (Reducing Plastic from Nature)**

Recommendations

- ◆ Encourage producers to **develop separate waste stream** for collection of plastic packaging waste and **issuance of EPR certification on achieving annual targets.**
- ◆ Include penalty for ULBs which do not set up **Plastic Waste Management systems.**
- ◆ **Incentivise producers and fund R&D** for developing eco-friendly alternative to SUPs.

Conclusion

As negotiations continue, the global community must demand a **framework that prioritises equity, accountability, and meaningful action.**

2.7 Revised Classification of Industries

Central Pollution Control Board (CPCB) has directed **State Pollution Control Boards (SPCBs)** to adopt a **revised classification of industries.**








About Revised classification

- ◆ CPCB introduced **Blue category** based on **Pollution Index (PI).**
- ◆ CPCB will **incentivize** industries which have demonstrated the successful **implementation** of **environmental management measures.**

Classification of Industries

- ◆ **Purpose:** To ensure that the industry is established in a manner which is consistent with the environmental objectives.

Existing Categories of Sectors

 Category	 PI	 Key detail / Examples
 Red	$PI > 80$	Not normally be permitted in ecologically fragile area / protected area. E.g. Cement, manufacturing of automobiles, distilleries, etc.
 Orange	$55 \leq PI < 80$	E.g. Brick manufacturing, dry cell battery, coal washeries, etc.
 Green	$25 \leq PI < 55$	E.g. Manufacturing of Compact disc Computer (CD/DVD), chilling plants, etc.
 White	$PI < 25$	These are non-polluting ; do not require Environmental Clearance (EC) and Consent. E.g. Assembly of air coolers, cardboard manufacturing, medical oxygen, etc.
Note: For any new or left-out sector, the SPCB/ Pollution Control Committees (PCCs) are allowed to categorize the sector at its own level.		

About Blue Category

- Includes **Essential Environmental Services (ESSs)** facilities which are essential to control, abate and mitigate pollution generated from **Domestic and Industrial activities**.
- Examples:** Municipal Solid Waste Management Facility, sewage treatment plants, etc.

Usage/Relevance of classification

- Sector specific plans for **Industrial pollution control**
- SPCBs/PCCs may prioritize **environmental surveillance** programs.
- Tool for progressive environmental management

Conclusion

The CPCB's revised classification of industries, including the introduction of the Blue category, reflects a progressive shift towards environmentally responsible industrial regulation.



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3. SUSTAINABLE DEVELOPMENT

3.1 World Coalition for Peace with Nature

"World Coalition for Peace with Nature: A Call for Life" Launched at **UN COP 16**.

About the Coalition

- ◆ Voluntary coalition to address environmental challenges by **changing human-nature relationship**.
- ◆ **Reaffirms:** Rights based approach of **Kunming Montreal Global Biodiversity Framework (KMGBF)**.

About Peace with Nature

- ◆ Emphasizes **interconnectedness of environmental issues** like **Triple planetary crisis** involving climate change, biodiversity loss, and pollution.
- ◆ **Significance:** Ecological sustainability, climate resilience, and biodiversity conservation.
- ◆ **Challenges:** Preference to **Short-term economic goals**, **lax attitude** towards environmental targets, and **growing human population**.

Conclusion

Need to **transform economic and financial systems** to include natural capital, **Shift taxation** from production to resource use and waste, offer **financial assistance** to developing countries, etc.

3.2 Environmental Accounting

Union Ministry of Statistics and Programme Implementation (MoSPI) released 8th **"EnviStats India 2025: Environment Accounts"**

About the EnviStats

- ◆ 1st EnviStats were released in **2018** on **Sir Partha Dasgupta Committee recommendations**.
- ◆ Compiled in accordance with the **SEEA (System of Environmental-Economic Accounting)** Framework.
 - ▶ SEEA is an **international framework** for **compiling Environment Economic accounts**, describing the **interaction** between economy and environment and **changes in environmental assets**.
 - ▶ **Two sides of SEEA**– SEEA–Central Framework (SEEA–CF) and SEEA–Ecosystem Accounting (SEEA–EA)
- ◆ **Includes four areas:** Energy Accounts, Ocean Accounts, Soil Nutrient Index, and Biodiversity.
- ◆ **Other initiatives in India:** **Gross Environment Product Index (GEPI)** by Uttarakhand; **Green GDP** by Chhattisgarh.

Significance of Environmental Accounting

- ◆ **Current parameters like GDP overlooks environmental depletion and degradation**
- ◆ **Balance economic growth** with environmental sustainability.

Challenges

- ◆ **High implementation costs**, especially for Small and Medium Enterprises.
- ◆ **Complexity** of environmental data.
- ◆ Lack of standardization.

Conclusion

Incorporating **environmental considerations** into **financial decision-making** could achieve cost effective sustainable growth.

3.3 Sustainable Agriculture in India






3.3.1. National Mission on Natural Farming (NMNF)

Union Cabinet approved **National Mission on Natural Farming (NMNF)** as a standalone **Centrally Sponsored Scheme** under **Ministry of Agriculture & Farmers' Welfare**.

About National Mission on Natural Farming

- ◆ **Tenure:** Till 2025-26
- ◆ **National Steering Committee (NSC):** At National level, under Chairpersonship of Minister of Agriculture & Farmers' Welfare.

Key Targets of NMNF

 15,000 clusters in Gram Panchayats, which are willing.	 Reach 1 crore farmers and initiate Natural Farming (NF) in 7.5 lakh Ha area .	 30,000 Krishi Sakhis (Community Resource Persons – CRP) for scaling of NF practices and knowledge.
 10,000 Bio-Input Resource Centres (BRCs) – cluster-level enterprise for locally prepared inputs/formulations utilizing biological entities	 ~2000 NF Model Demonstration Farms to be established at Krishi Vigyan Kendras (KVKs), Agricultural Universities (AUs) and farmers' fields.	

About Natural Farming (NF)

- ◆ **Chemical free, low-input, climate-resilient system** based on locally available resources.
- ◆ **Key Components:** **Beejamrit** (cow dung, urine, etc.); **Jivamrit** (bio-stimulant for microorganism activity); **Mulching** (covering soil using live crops); **Whapasa** (using earthworms); **Plant Protection** (using biological concoctions), etc.
- ◆ **Significance:** Improved yield; Environmental conservation; better soil and human health, etc.
- ◆ **Key Issues:** Yield uncertainty; input supply issues through availability of cow dung and urine; etc.

Differences with Organic Farming

Parameter	Organic Farming	Natural Farming
Input	Off-farm purchased organic inputs.	On-farm inputs.
Agro Practices	Ploughing, tilting, mixing of manures, weeding, etc.	Decomposition of organic matter by microbes and earthworm.
Cost	More expensive	Low cost

Other Initiatives to promote Natural Farming

- ◆ National Centre for Management of Agriculture Extension (MANAGE)
- ◆ **National Centre for Organic and Natural Farming (NCONF)**
- ◆ **State level initiatives:** Prakritik Kheti Khushhal Kissan (PK3) Yojana, Himachal Pradesh, Andhra Pradesh Community Managed Natural Farming (APCNF)

Conclusion

NMNF aims to enhance **agriculture practices** with **scientifically supported approaches** for **sustainability, climate resilience, safe food**, and **reduced farmer input costs**.

3.3.2. Agroforestry

Economic Advisory Council to the PM (EAC-PM) highlighted the untapped potential of agroforestry in India.

About Agroforestry

- ◆ Defined In India as the tree cover % **greater than 10% on agricultural land**.
- ◆ **Types: Silvopastoral** (trees and livestock); **Silvoarable** (trees and crops); **Hedgerows and buffer strips** (sacred groves, Devrai in Maharashtra) etc.
- ◆ **Covers 8.65% (28.42 million hectares)** of India's total geographical area.
- ◆ **Traditional methods of Agroforestry:** Itteri system (Tamil Nadu); Khejri System (Arid North -west regions like Rajasthan) etc.

Significance

- ◆ **~93 %** of India's domestic timber is from agroforestry plots.
- ◆ **Stores up to 30% more carbon** than traditional agricultural systems.
- ◆ Help meet the target of increasing forest/tree cover to **33% [National Forest Policy (1988)]**.

Issues related to Agroforestry in India

- ◆ **Procedural complexities: National Transit Pass System (NTPS)**, only issues transit permits and not tree felling permits.
- ◆ **Unutilized potential:** Only **17% of total agricultural land** is under agroforestry.
- ◆ **Import dependence:** India imported **~USD 2.7 billion worth** of timber (2023).
- ◆ **Others:** Multiple state laws (Agriculture, a state subject), etc.

India's approach & Initiatives taken

- ◆ **National Agroforestry Policy**
- ◆ **Sub-Mission on Agroforestry (SMAF)**
- ◆ **GROW initiative:** By NITI Aayog
- ◆ **2017 Amendment to the Forest Act 1927:** Redefined bamboo from a tree to grass.

Way Forward

- ◆ **Arun Kumar Bansal committee:** Emphasized participatory approach.
- ◆ **Recommendations in National Agroforestry Policy:** Institutional Setup at National level to **promote Agroforestry; Decentralized institutions**, like Gram Sabha, etc.

Conclusion

Unlocking its Agroforestry's full potential in India requires policy simplification, strengthened local governance, and sustained institutional support.

3.3.3. Other Sustainable Agriculture Practices in News

Integrated Nutrient Management (INM)

- ◆ **Maintains soil fertility** and **plant nutrient supply** for sustaining desired productivity.
- ◆ **Optimizes benefits** from organic, inorganic, and biological components.
- ◆ **Significance:** Enhances soil health, sustainable crop production, and cost-effectiveness.
- ◆ **Challenges:** Careful decision-making, nutrient management knowledge, and remote access.
- ◆ **Conclusion:** INM can ensure holistic nutrient supply to crops by right information and research.

Regenerative Agriculture (RA)

- ◆ **Harmonizes farming with nature**, involving principles of minimizing soil disturbance, maximizing crop diversity, maintaining soil cover, integrating livestock.
- ◆ **Benefits:** reduce soil erosion and greenhouse gas emissions
- ◆ **Challenges:** high adoption cost, initial yield loss.
- ◆ **Conclusion:** To make it viable, **financial intervention and technical capacity building** is needed.

3.4 Miscellaneous

3.4.1. Digitization and Environmental Sustainability

Declaration on **Green Digital Action (GDA)** adopted by **COP 29 of UNFCCC**.

Key Highlights of the Declaration

- ◆ **Leveraging digital technologies** for climate action and building resilient digital infrastructure.
- ◆ **Mitigate impacts of digitization on climate** by establishing metrics to measure its environmental impact.
- ◆ **Environmental footprint of Digitalization (UN Trade and Development's Digital Economy Report 2024)**

- ◆ ICT sector accounts for **1.5– 3.2 % of global GHG emissions** in 2020.
- ◆ 30% rise in **digital related waste** from 2010 to 2022.
- ◆ In 2022, Global data centres alone **consumed 460 terawatts hours** power (expected to double by 2026).
- ◆ Demand for minerals required for digitalization like graphite, lithium, and cobalt could surge by **500 % to 2050**.

Significance of Digital Technologies in Sustainable Development

- ◆ **Monitoring:** E.g., AI could **measure changes in icebergs 10,000 times faster** than a human.
- ◆ **Informed decision making:** Data analytics, cloud computing, etc.
- ◆ **Sustainable Design approaches:** Stress on **circular economy model**.
- ◆ **Promoting Open data sources:** E.g., **Digital Public Infrastructure, etc.**
- ◆ **Role in Disaster Management:** **Climate monitoring and forecasting**.
- ◆ **Collective Intelligence:** People work with **technology** to mobilize information, ideas, and insights, etc. E.g., Agrolly app for crop information, etc.

Conclusion

United Nations Environment Programme (UNEP) recommends adapting **standardized procedure**, encourage companies to power data centres with **clean energy, etc.**

3.4.2. Indian Himalayan Region (IHR)

Recent Supreme Court judgments relating to climate change necessitate a **sustainable development model for IHR**.

Key judgments

- ◆ **MK Ranjitsinh vs. Union of India case (2024):** Right to be free from the adverse effects of climate change under Articles 14 and 21.
- ◆ **Ashok Kumar Raghav vs Union of India case (2023):** SC asked the central government to suggest a way forward regarding **carrying capacity** of the Himalayan States/towns.
- ◆ **State of Telangana vs Mohd. Abdul Qasim case:** Adoption of an ecocentric view of the environment (where nature is at the core).

Importance of IHR

- ◆ Himalayan glaciers feed majority rivers
- ◆ **Barrier** for Frigid dry arctic winds and monsoon winds.
- ◆ **Biodiversity Hotspot:** Himalaya Hotspot and the Indo-Burma Hotspot
- ◆ **Carbon Sink** (stores 5.4 billion tonnes of carbon).
- ◆ **Provides resources** like gucchi mushroom.

Challenges associated with IHR

- ◆ **Himalayan states reported loss** of 1,072 sq km of forest cover (2019 -2021).
- ◆ **Gangotri glacier (Uttarakhand Himalaya) retreated** by 1,700 metres between 1935 and 2022.
- ◆ IHR records **~100 million tourists every year**.
- ◆ Many urbanised towns (E.g., Shimla, Mussorie) already **exceeded their carrying capacity**.

Initiatives to Protect the Ecosystem of the Himalayan Mountain System

- ◆ **India's Initiatives:** National Mission for Sustaining the Himalayan Ecosystem (NMSHE); Centre for Cryosphere & Climate Change Studies; Sustainable Tourism & Waste Management: Swadesh Darshan Scheme, etc.
- ◆ **Global Initiatives:** International Centre for Integrated Mountain Development (ICIMOD); SECURE Himalaya Project

Way-forward

- ◆ **"Himalayan Authority"** to coordinate integrated and holistic development of the region.
- ◆ **"Smart Mountain Tourism Destinations"** similar to Smart Cities
- ◆ Introduce **'Green Cess'** (Payment for Environmental Services) based on eco-certification, etc.
- ◆ Building on best practices, (e.g., **Dhara Vikas in Sikkim** and others) for revival of springs.

Conclusion

There is a need for **stronger conservation** measures to **address habitat loss, illegal wildlife trade, forest fires, etc.**

3.4.3. Great Nicobar Island

NITI Ayog Draft Report on Greenfield International Airport – Great Nicobar released.

Concerns with the Project

- ◆ **Environmental concerns like** Loss of top soil, sewage waste generation, impact on mangroves.
- ◆ Artificial beach illumination impacts **sea turtles** (like leatherback turtle, and Nicobar megapode).
- ◆ **Lack of transparency** and hasty consent process.
- ◆ Shompen tribe remain **vulnerable to infectious diseases**.
- ◆ A&N located in **high-risk seismic zone**.

Way forward (Environmental Impact Assessment (EIA) report)

- ◆ **Measures: Halt construction** during leather back turtles' breeding season, use **sodium vapor lights, Solid waste management system**.
- ◆ **Policy Reforms: Implement Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013** for displaced people, etc.

Conclusion

Balance between development and conservation should be guided by environmental responsibility and cultural sensitivity.



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4. RENEWABLE ENERGY AND ALTERNATIVE ENERGY RESOURCES

4.1 Nuclear Energy Mission

Union Finance Minister announced a dedicated **Nuclear Energy Mission in the Union Budget 2025–26**.

About Nuclear Energy Mission

- ◆ **Target:** To achieve **100 GW of nuclear power capacity by 2047**
- ◆ **Current Status:** Installed nuclear energy capacity is **8.18 GW as of January, 2025**.
- ◆ **Aim:** Development of **small modular reactors (SMRs)** and setting up of at least 5 SMRs by **2033**.

Key Features

- ◆ **Private Sector Participation through** Proposed changes to **Atomic Energy Act, 1962**, and **Civil Liability for Nuclear Damage Act, 2010**.
- ◆ **Partnerships with private sector with motive of:** Setting up **Bharat Small Reactors (BSRs)**, Research & development of **Bharat Small Modular Reactor (SMR)**, and Research & development of **newer technologies** for nuclear energy.

Relevance of Nuclear Energy for India

- ◆ India home to one of **world's largest thorium deposits**.
- ◆ **Overcome issues in expanding RE in India:** E.g. Low waste/Pollution, Limited land requirement.
- ◆ **Strengthening Energy Security Through Indigenous Capabilities**

Challenges with respect to Nuclear Energy for India (Economic Survey)

- ◆ **Public concerns about safety**
- ◆ **Geographical concentration of uranium** and other essential minerals.
- ◆ **Shortfall of Sulphuric Acid** for uranium extraction.
- ◆ **Lack of a supportive ecosystem** and the monopolistic nature of nuclear fuel supply chains.

Way-Forward

- ◆ **Standardization and Licensing by regulatory frameworks** to facilitate the deployment of SMRs.
- ◆ **Consideration of Safeguards requirements** during early stages of SMR designs
- ◆ **Innovative Financing Framework**

Conclusion

With its **vast thorium reserves and strong institutional capabilities**, nuclear energy can play a crucial role in achieving India's climate goals and "Viksit Bharat" vision.

4.2 Solar Energy in India

India has achieved a historic milestone by crossing **100 GW** of solar power capacity, with **PM Surya Ghar: Muft Bijli Yojana (PM-SGBY)** powering 10 lakh homes as of March 2025.

Status of solar energy in India

- ◆ Ranks **5th in Solar Power Capacity globally** with **Installed solar energy capacity** of 110 GW (Power Ministry, June 2025)
- ◆ **Potential in India:** 748 Giga Watt peak (**National Institute of Solar Energy**).

Significance of Solar energy in India

- ◆ **Rural Electrification through off-grid power generation** with fast capacity expansion.
- ◆ **Cost-saving:** E.g., Under PMSGMBY, 1 crore families are expected to **save Rs 15000 crore annually** through reduced electricity bills.
- ◆ **Reducing reliance on central grid**, minimizing transmission losses, and enabling better load management.

Factors behind growth of Solar Energy in India

- ◆ **Abundant solar radiation:** With **~300 sunny days per year** and **4–7 kWh/m²/day**.

- ◆ **Financial support:** India allowed 100% of foreign direct investment (FDI).
- ◆ **Indigenous manufacturing of solar components:** Through initiatives like Solar Park Scheme
- ◆ **International Cooperation and Leadership:** E.g. International Solar alliance.

Challenges Related to Solar Energy in India

- ◆ Solar can need **300 times space as nuclear energy** (Economic Survey 2023–24).
- ◆ Extraction of minerals leave large **scars in landscape and require substantial water**. (Economic Survey 2023–24)
- ◆ **Decline in the Solar photovoltaic Potential (SPV)** due to increase in aerosol load from carbon emissions (IMD Study)
- ◆ **High dependency on Imports:** E.g., reliance on China for components/minerals
- ◆ **Gaps in R&D and Technology:** India lags in adoption of latest solar cell technologies.

Initiatives taken to Promote Solar Energy

- ◆ **PM Surya Ghar Muft Bijli Yojana**
- ◆ **Grid Connected Solar Rooftop Programme**
- ◆ **Production-linked incentive scheme under National Programme on high efficiency Solar PV Modules**
- ◆ **Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM)**

Way Forward

- ◆ **Expansion of PLI Scheme** to **cover early-stage solar manufacturing**.
- ◆ **Promote agrivoltaics** and increase development of floating solar panels.
- ◆ **Other:** Harmonizing state and central policies; Circular economy approach, **Reassessment of current import duties** on solar modules, **Collaboration with countries etc.**

Conclusion

A balanced approach, combining financial incentives, technological innovation, and international cooperation, will be crucial in making solar energy a cornerstone of India's energy security and green growth strategy.

4.2.1. International Solar Alliance (ISA)

Recently, **Paraguay** became the 100th country to join the International Solar Alliance (ISA).

About International Solar Alliance (ISA):

- ◆ **Treaty-based intergovernmental organization** for increased deployment of solar energy technologies.
- ◆ **Jointly announced by India and France** in 2015 at UN Paris Climate Change Conference (**COP-21 of UNFCCC**).
- ◆ Guided by 'Towards 1000' strategy:
 - ▶ Mobilise USD 1,000 billion of investments **in solar energy solutions by 2030**
 - ▶ Deliver energy access to 1,000 million people **using clean energy solutions**
 - ▶ Installation of **1,000 GW of solar energy capacity**.
 - ▶ Mitigate global solar emissions to the tune of **1,000 million tonnes of CO₂ every year**.

Significance of ISA

- ◆ **Differentiated approach** for High-income countries, Emerging economies, Low-income countries and SIDS.
- ◆ **Creation of a global solar energy market.**
- ◆ **Facilitate standardised policies.**
- ◆ **Platform for collaborative Research and Development.**
- ◆ **Significant shift in India's Foreign Policy** to further strategic interests. E.g. Mission LiFE.

Initiatives taken by ISA

- ◆ **One Sun One World One Grid (OSOWOG)**
- ◆ **Solar Technology Application Resource Centre (STAR C)**
- ◆ **Global Solar Facility**
- ◆ **Development of Large-Scale Solar Power Projects** under **Solar Park** Concept in ISA Member Countries.
- ◆ **ISA Solar Fellowship for Mid-Career Professionals**

Challenges for ISA

- ◆ **Coordination issues among member states** hinders effective **implementation** of initiatives.
- ◆ **China dominates the global solar supply chain.**
- ◆ **Private sector participation** may make renewable energy **inaccessible**.
- ◆ **Other:** Issues of land acquisition & Technical challenges E.g. Grid integration.

Conclusion

Addressing **regional disparities**, ensuring **equitable energy access**, and adopting a **people-centric, inclusive approach** are key to accelerating solar adoption.

4.3 National Green Hydrogen Mission

MNRE has released Scheme Guidelines for development of Standards and Regulatory framework under the **National Green Hydrogen Mission**.

About National Green Hydrogen Mission (NGHM) (2023)

- ◆ **Duration:** Phase I (2022-23 to 2025-26) and Phase II (2026-27 to 2029-30).
- ◆ **Objective:** To make India a Global Hub for production, usage and export of Green Hydrogen and its derivatives.
- ◆ **Key components:** **Facilitating demand creation; Strategic Interventions for Green Hydrogen Transition (SIGHT)** programme; and **Development of Green Hydrogen Hubs**
- ◆ **Expected Outcomes:**
 - ▶ Development of green hydrogen production capacity of at least **5 MMT (Million Metric Tonne) per annum**.
 - ▶ Abatement of **50 MMT** of annual GHG emissions

About Green Hydrogen (GH₂)

- ◆ **Hydrogen produced through electrolysis**, using **electricity generated from renewable sources** like solar, wind, hydro etc.
- ◆ Also produced from **biomass**, which involves the gasification of biomass to produce hydrogen.
- ◆ **Benefits of Hydrogen as a fuel:** Lower emissions; Decarbonize sectors like transportation, shipping, and steel, etc.; Power and Efficiency (3 times as powerful as gasoline).
- ◆ **Applications of GH₂:** Fuel Cell Electric Vehicles (FCEVs) Aviation and Maritime, Industry (Fertilizer Refinery, Steel, Transport (Road, Rail), Shipping, Power Generation.)

Challenges in green hydrogen adoption

- ◆ **High production cost.**
- ◆ Requires **high-pressure tanks** and cryogenic temperatures for storage.
- ◆ Green hydrogen production can require up to **9 Liters of water per kilogram**.
- ◆ **Other issues:** Lack of Skill In domain of hydrogen production; Lack of global standards on carbon intensity & safety etc.

Conclusion

Lowering production costs, providing incentives like **the PLI scheme**, ensuring **adequate financing**, and establishing an expert-led PMU are essential to advancing green hydrogen in India.

4.4 Ethanol Blending

India is gearing up to set a new target of **30% ethanol blending** in petrol by 2030, having already achieved a 20% blend (**March 2025**).

What is Ethanol Blending?

- ◆ It involves a **blended motor fuel containing ethyl alcohol**.
- ◆ **Key Targets:** Targets of **20% ethanol blending in petrol** by 2025 (Updated) and **5% biodiesel blending** in diesel by 2030. (National Policy on Biofuels, 2018 and Ethanol blending Program (EBP))
- ◆ **Significance**
 - ▶ **E20 reduces carbon monoxide emission** by ~30% in 4-wheelers compared to petrol

- ▶ Reduced import dependency and Boost to farmer income

Challenges in Ethanol Blending

- ◆ **Producers:** Availability of feedstock, weather related issues
- ◆ **Oil Marketing Companies:** Need for additional storage tanks, logistics cost and emissions
- ◆ **Vehicle manufacturers:** Optimization of engine for higher blends, conduct of durability studies on engines.

Initiatives launched for Ethanol Blending

- ◆ **Reduced GST** (from 18 to 5%) on ethanol.
- ◆ **PM JI-VAN YOJANA.**
- ◆ **Flexi-fuel engines** and components included under PLI scheme.
- ◆ **Amendment of Industries (Development & Regulation) Act, 1951** to ensure free movement of ethanol.

Way Forward

- ◆ Ensure **uniform availability of ethanol blends** across India.
- ◆ Augmenting **infrastructure of Oil marketing companies.**
- ◆ **Providing tax incentive** to absorb R&D cost on E20 compatible design, etc.
- ◆ Encouraging use of **water saving crops** to produce ethanol. **E.g. Maize**
- ◆ Production from **non-food feedstock** to prevent tradeoff with food security

Conclusion

Ethanol Blending has significantly enhanced foreign exchange savings, reduced carbon emissions, and supported sugar industries. It plays a vital role in promoting energy security, environmental sustainability, and rural economic stability.

4.5 Geothermal Energy in India

India has identified a potential of approximately **10,600 MW of geothermal power** (Geological Survey of India).

About Geothermal Energy

- ◆ **Heat energy** from the earth—**geo (earth) + thermal (heat).**
- ◆ **Potential in India:** ~300 geothermal hot springs.
- ◆ **Puga and Chumathang in eastern Ladakh** most promising sites.

Potential Issues of Geothermal Energy

- ◆ **Possible land subsidence, high transportation charges** (Due to remote plant location).
- ◆ **Possible release of toxic chemicals** e.g. mercury, arsenic, boron, and antimony.
- ◆ **Other Issues:** Higher capital costs, techno-economic viability issue due to remote location

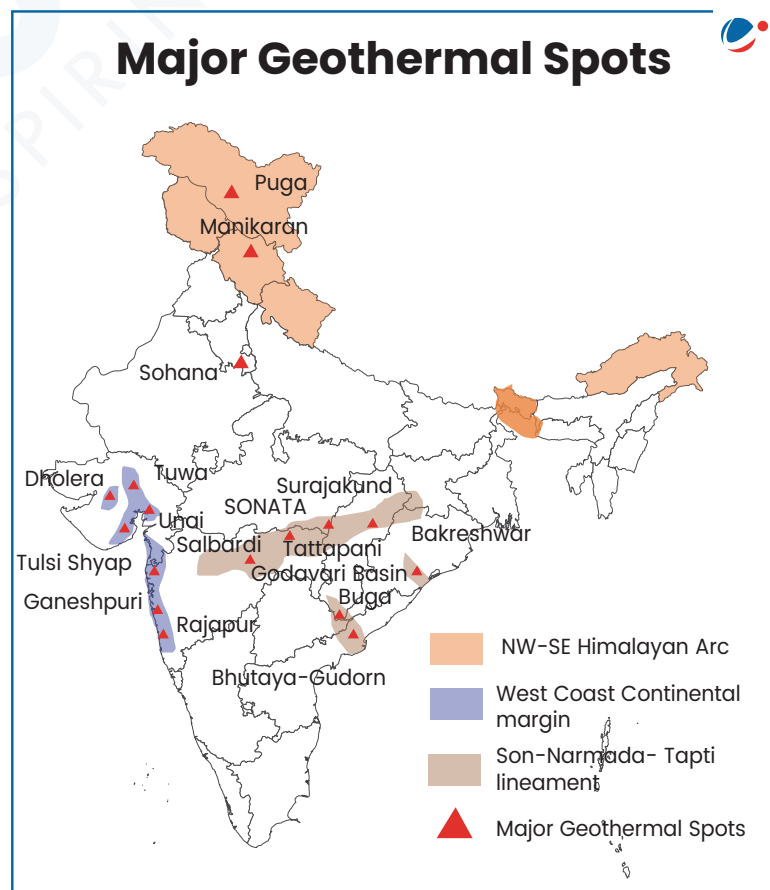
Initiatives in India

- ◆ **Renewable Energy Research & Technology Development Programme (RE-RTD)**
- ◆ **100% financial support by MNRE to government/ non-profit research organizations.**
- ◆ **Singareni Collieries Company limited** commissioned a 20 kW pilot geothermal power plant in Manuguru.

Conclusion

Advancing geothermal energy in India requires **detailed geological mapping, increased R&D incentives for cost-effective extraction technologies, and investment in infrastructure** for efficient power distribution.

Major Geothermal Spots



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5. CONSERVATION EFFORTS

5.1. International Treaties and Conventions

5.1.1 CoP-16 to the UNCBD

CoP-16 to UN Convention on Biological Diversity (UNCBD) concluded in **Cali, Columbia**.

Key Outcomes

- ◆ **Operationalisation of Cali Fund** for fair benefit sharing.
- ◆ Companies benefiting from **Digital Sequence Information (DSI)** to **contribute 1%** of their profit to **support Indigenous Peoples and local communities**.
 - ▶ DSI is the **genomic sequence** and other related digital data of organisms for research.
- ◆ Recognition of **rights of Indigenous Communities** by a **permanent subsidiary** body under **Article 8(j) of the UNCBD and Cali Fund**.
- ◆ Launch of **Kunming Biodiversity Fund (KBF)** under **Global Environment Facility (GEF)**.
- ◆ Identification of **Ecologically or Biologically Significant Marine Areas (EBSAs)**.

Shortcomings

- ◆ **Developed countries lagged** in their commitment to provide **\$20 billion annually by 2025**.
- ◆ **Only 44 member states** submitted their updated National Biodiversity Strategy and Action Plan (NBSAP) aligned with KMGBF.
- ◆ **Lack of consensus** on contributions to Cali Fund.
- ◆ **Disagreements over biodiversity credits and offsets**.
- ◆ **Others:** No decision on updating and completing the **monitoring framework** under KMGBF; delay in **Planning, Monitoring, Reporting, and Review (PMRR)** mechanisms, etc.

About UNCBD

- ◆ **International legally binding** treaty, operates under UNEP, adopted at **Earth Summit, Rio de Janeiro, in 1992**.
- ◆ **Protocols/Targets:** Cartagena Protocol on Biosafety, Nagoya-Kuala Lumpur Supplementary Protocol, Nagoya Protocol on Access and Benefit Sharing; Aichi Biodiversity Targets; Kunming-Montreal Global Biodiversity Framework (KMGBF).
 - ▶ **Key Targets of KMGBF**
 - ◆ **30-by-30 Target** (i.e. 30% conservation of land, sea, and inland water, degraded ecosystem by 2030.)
 - ◆ Reducing introduction **of invasive alien species by 50% by 2030**
 - ◆ **Mobilizing \$200 billion annually**, including \$30 billion through international finance.

Conclusion

Roadmap for CoP-17 in Yerevan, Armenia, 2026 lies in strengthening Monitoring and enhancing NBSAPs with time-bound action plans.

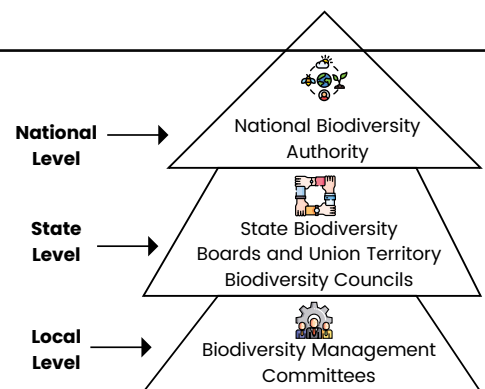
5.1.2 National Biodiversity Strategy and Action Plan (NBSAP)

India Updated its **NBSAP for 2024-30**, required by every party under **Article 6 of UNCBD**.

Key Highlights of Updated NBSAP (First created in 1999)

- ◆ Aligns with **Aichi Biodiversity Targets** and **KMGBF** and adopts **'Whole of Government'** and **'Whole of Society'** approach.
- ◆ Includes **23 National Biodiversity Targets (NBTs)** on **three themes**—reducing threats to biodiversity; ensuring sustainable use of resources; and enhancing tools for implementation.
- ◆ **Implementation** by the **Ministry of Environment, Forest and Climate Change (MoEFCC)**.
- ◆ **Governance structure: Multi-tier** (refer infographic) under **Biological Diversity Act, 2002**.

Architecture for the implementation of NBSAP



NOTE: Ministry of Environment, Forest and Climate Change (MoEFCC) serves as the central agency responsible for coordinating biodiversity conservation efforts across India

- ◆ **Resource mobilization:** Through **Biodiversity Finance Initiative (BIOFIN)** [Global partnership launched by **UNDP** and **European Commission**].

Significance

- ◆ **Ecosystem Based Management** Approach.
- ◆ Outlines strategies to address challenges through **ecosystem restoration**.
- ◆ Provides insights on **biodiversity status and future strategies**.
- ◆ **Robust Implementation** through bottom-up approach, mainstreaming biodiversity, sectoral integration, and inter-agency cooperation.

Conclusion

Need to Integrate **traditional practices** with **modern governance** to deal with contemporary environmental challenges.

5.1.3 High Seas Treaty

India approves **Biodiversity Beyond National Jurisdiction (BBNJ) Agreement** for implementation by **Ministry of Earth Sciences**.

What are High Seas?

- ◆ Areas **outside the national jurisdiction** of any country (**National jurisdictions extends up to 200 nautical miles** (370 km) from coastline, called **Exclusive Economic Zone (EEZ)**).
- ◆ **Constitute about two-thirds** of total ocean area and considered **global commons**.

About BBNJ Agreement

- ◆ Formally called **Agreement on Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction**.
- ◆ International treaty under the **United Nations Convention on the Law of the Sea (UNCLOS)**.
- ◆ **Key Guiding Principles:** Polluter Pays, Common Heritage of Humankind; Freedom of Marine Scientific Research; Equity and Fair and Equitable Sharing of Benefits; etc.

Key provisions of BBNJ Agreement

- ◆ **Coverage:** Areas Beyond National Jurisdiction (ABNJ), including **high seas**.
- ◆ **Institutional Arrangement: Conference of Parties (COP)** [Main decision making body], Scientific and Technical Body (STB), Clearing-House Mechanism (CHM).
- ◆ **Financial Mechanism:** Voluntary Trust Fund, Special Trust Fund, Global Facility Fund.
- ◆ **Four Substantive Elements:** Marine Genetic Resources (MGR), Area-Based Management Tools (ABMT), Environmental Impact Assessments (EIAs), Capacity-Building and the Transfer of Marine Technology.

Significance of BBNJ Agreement

- ◆ **Equitable economic order** including interests of developing states.
- ◆ **Strategic expansion of India** in areas beyond the Exclusive Economic Zone (EEZ).

Conclusion

Treaty would help in achieving the **"30x30" target** to protect 30% of marine ecosystems by 2030.

5.1.4 Antarctic Treaty

Recently, **46th Antarctic Treaty Consultative Meeting (ATCM)** and **26th Committee on Environmental Protection (CEP)** hosted by the **National Centre for Polar and Ocean Research, Ministry of Earth Sciences** concluded.

About Antarctic Treaty

- ◆ **Genesis:** Signed in Washington, **1959** by **12 countries** & enforced in **1961**.
- ◆ **Members:** 57, of which 29 are **consultative parties** (**India**, a consultative Party since 1983).
- ◆ **Applicability:** Area south of 60° South latitude.
- ◆ **Key provisions:** Peaceful use of the region; International scientific cooperation; Prohibit nuclear explosions, radioactive waste disposal, and military deployments.

Related Agreements

- ◆ **Protocol on Environmental Protection to the Antarctic Treaty (1991)**
- ◆ **Convention for the Conservation of Antarctic Seals (1972)**
- ◆ **Convention on the Conservation of Antarctic Marine Living Resources (1980)**

About Antarctica Region

- ◆ Area **south of 60 degrees South Latitude**.
- ◆ **Thick ice covers about 98% of the land**.
- ◆ Has **Largest international Marine Protected Area** i.e., **Antarctica's Ross Sea**.
- ◆ **Significance:** Regulation of Global Climate; Slows Global Heating; etc.

Threats to the Region

- ◆ **Melting of Floating ice shelves**.
- ◆ Average **summer temperatures increasing** by ~3°C between 1970 and 2020.
- ◆ **Impact on Biodiversity** including marine ecosystems, collapse of fish stock, etc.

India's initiatives for Antarctica

- ◆ First research station: **Dakshin Gangotri** (1983).
 - ▶ Current research stations: **Maitri** (1989) and **Bharati** (2012).
 - ▶ In **ATCM- 46** India announced a plan to set up an, **Maitri-II**.
- ◆ In 2022, India enacted the **Indian Antarctic Act, 2022**.

Conclusion

The Treaty is amongst **successful international agreements** for **ongoing protection** of an undisturbed continent.

5.2. Forest and Wildlife Conservation

5.2.1 Western Ghats

Karnataka government **rejected the Kasturirangan committee report** on protection of Western Ghats (WG) region.

More on the News

- ◆ **Kasturirangan committee** proposed 37% of the WG, to be declared as **Eco-sensitive Area (ESA)**.
- ◆ In June, **Karnataka, Maharashtra and Goa**, sought reduction of ESA post centre notification.
- ◆ MoEF&CC issued a draft notification on the WG as an ESZ.

About ESZ

- ◆ **Ecologically important and fragile areas** around protected areas notified under **Environment (Protection) Act, 1986**. E.g., Doon Valley, Bhagirathi, Western Ghats, Mount Abu, etc.
- ◆ **Category of activities allowed (ESZ Guidelines)**
 - ▶ **Prohibited:** Commercial Mining, setting of industries causing pollution, etc.
 - ▶ **Regulated:** Felling of Trees, Establishment of hotels and resorts, etc.
 - ▶ **Permitted:** Ongoing agriculture and horticulture practices by local communities, dairy farming, etc

Significance of the Western Ghats

- ◆ **One of the world's eight 'hottest biodiversity hotspots'** declared in **2012** by UNESCO.
- ◆ **Caters to water needs of ~245 million people** in the peninsular areas.
- ◆ **~63% of India's woody evergreen taxa and medicinal plants are endemic**.
- ◆ **Rich in iron, manganese and bauxite** ores in parts of the ranges.

Threats and Issues in Western Ghats

- ◆ **Anthropogenic impacts** like Urbanisation, and **global warming**.
- ◆ **Issues with Implementing Committee Recommendations** due to opposition by States.

Way Forward

- ◆ **Western Ghats Ecology Authority** to oversee the regulatory framework.
- ◆ **Western Ghats Sustainable Development Fund** to incentivise green growth, etc.

Conclusion

Western Ghats serve as an **important wildlife corridor** characterised by **high ecological sensitivity**.

5.2.2 National Board for Wildlife (NBWL)

PM chaired the **7th** meeting of NBWL occurring after 10 years at **Gir National Park in Gujarat**.

About the National Board for Wildlife

- ◆ **Statutory body** established in 2003 after amending the **Wildlife (Protection) Act, 1972**.
- ◆ Constituted as **advisory body** during 1952, designated as **Indian Board for Wildlife (IBWL)**.
 - ▶ **IBWL** was instrumental in setting in place the **Wild Life Protection Act, 1972**, establishing **Gir National Park for Asiatic Lions**, declaring **tiger as national animal**.
- ◆ **Members: Chairperson**–Prime Minister of India, **Vice–Chairperson:** Union Minister of Ministry of Environment & Forests and climate change etc.

Functions of NBWL

- ◆ Promote the **conservation and development** of wild life and forests.
- ◆ **Framing policies** and advising Central and State Governments on conserving wildlife.
- ◆ **Recommendations regarding** setting up and management of protected areas like national parks.
- ◆ **Carrying out** impact assessment of various projects and activities.

Concerns related to NBWL

- ◆ **Approving Projects in Protected Areas:** E.g., **Ken–Betwa project**, was cleared despite submergence of nearly **100 sq km** of the **Panna Tiger Reserve**.
- ◆ **Threats to Endangered Species:** E.g., **Oil exploration** in Hollongapar Gibbon Sanctuary (Assam).

Way forward

- ◆ **Need for Expertise:** Through **qualified wildlife scientists**, and **conservation NGOs**, etc.
- ◆ **Institutionalize Local Community Participation:** Free, Prior, and Informed Consent (FPIC).
- ◆ **Leveraging scientific and technological tools** like AI–Based habitat modelling.





Conclusion

Role of NBWL is of critical importance to ensure the **long-term protection of India's biodiversity**.

5.2.3 Agriculture and Biodiversity Conservation

Recently, **Union for Conservation of Nature (IUCN)** released its flagship report **"Agriculture and Conservation"**.

Relationship between agriculture and conservation

Impact of Agriculture on Biodiversity	Impact of Biodiversity on Agriculture
 Positive: ~17% of species on IUCN Red List have agriculture documented as a habitat.	 Positive: Provisioning of services (production of biomass, etc.), regulating and maintenance services (climate regulation, etc.).
 Negative: Threatens 34% of species on the IUCN Red List of Threatened Species, direct threats (conversion of natural habitats to croplands), indirect (introduction of invasive species, etc.).	 Negative: Ecosystem disservices such as crop predation, pests and pathogens.

Key Measures to align Agriculture with Conservation

- ◆ **Financing For Sustainable Agriculture:** Increasing role of collectives like FPOs, etc.
- ◆ **Innovative Practices:** Use of Green Manure (E.g., Dhaincha in Tamil Nadu) for soil fertility.
- ◆ **Sustainable Nitrogen Management:** Biological nitrogen fixation using leguminous crops (e.g., soybean, alfalfa, etc.).
- ◆ **Aquatic Foods:** UNFCCC Ocean Dialogue (2023) recognized aquatic foods' role (fisheries and aquaculture) for climate solutions.
- ◆ **Policy Reforms:** Globally **less than 5% of agricultural subsidies** are green subsidies.

Conclusion

Adoption of digital agriculture solutions and **innovative agri-technologies** can align agriculture with biodiversity conservation.

5.2.4 Human-Wildlife Conflict

Recent **Wolf Attacks** in Bahraich, Uttar Pradesh raised concerns about Human-Wildlife conflict.

About Human-Wildlife Conflict (HWC)

- ◆ **Encountered between humans and wildlife leading to negative results**, like loss of life and livelihood (WWF).
- ◆ **Management in India:** Primary responsibility of the respective **State/ UT Government**.
- ◆ **Some Examples of HWC:** Predation on livestock; Damage to crops/fences; etc.
- ◆ **Impacts:** Retaliatory killing, Rising zoonotic diseases; psychological Impact on Communities Damage to crops.

Causes

- ◆ **Seasonal changes and Extreme weather events:** E.g., Arctic Ice Melting increases Human-polar bear interaction.
- ◆ **Changes in Land use, expansion of agriculture.** E.g., Sunderbans reaching its carrying capacity.
- ◆ **Changes in animals movement patterns, life cycles, etc.**

Laws and Policy to tackle HWC

- ◆ Forest and wildlife under **Concurrent List**.
- ◆ **Wildlife Protection Act of 1972**.
- ◆ **Standard Operating Procedures (SOPs):** Issued by Central government.
- ◆ **Others:** National Wildlife Action Plan 2017-2035 (NWAP).

Way forward: National wildlife Action Plan (2017-2035)

- ◆ **Science-based plans for** species-specific and region-specific.
- ◆ **Participation of local community.**
- ◆ **Centre of Excellence (CoE)** under **Ministry of Environment, Forests and Climate Change**.

Conclusion

Rising human-wildlife conflicts demand science-based strategies, legal enforcement, and community participation to ensure coexistence and protect both lives and biodiversity.

5.3. Ramsar Convention

Recently, new Ramsar sites were recognized under **Ramsar Convention** now totalling **91** in India.

About Ramsar Convention

- ◆ **Intergovernmental treaty for conservation and wise use of wetlands** (maintenance of their ecological character, achieved through implementation of ecosystem approaches, within the context of sustainable development).
- ◆ Adopted at **Ramsar (Iran) in 1971** and enforced in **1975**.
- ◆ **'List of wetlands of international importance' (Ramsar List)** contains wetlands holding **significant value for humanity**.
- ◆ **Sites in India: Oldest (Chilika Lake, Odisha and Keoladeo National Park, Rajasthan [1981]) and Latest (Khichan and Menar, both in Rajasthan [2025]).**
 - ▶ **Wetland City Accreditation (WCA):** Indore and Udaipur.
- ◆ **Montreux Record:** Ramsar sites where changes in ecological character have occurred/occurring/ likely to occur. **Examples:** Loktak (Manipur) and Keoladeo National Park (Rajasthan).
- ◆ **Significance of Convention:** Fulfil Sustainable Development Goals; Research and Data Exchange among Parties; International Cooperation.

About Wetlands

- ◆ Land area **saturated or flooded** with water, either seasonally or permanently.
- ◆ **Current Status in India: 7 lakh wetlands** covering **~16 Mha i.e., 4.86%** of total area.
- ◆ **Significance of Wetlands:** Carbon sink and Water storage; Nature's shock absorber (prevents coastal erosion); Kidneys of landscapes (filters out contaminants), etc.
- ◆ **Schemes/Policies/Initiatives:** Wetland (Conservation and Management) Rules 2017; National Mission for Clean Ganga (NMCG); Blue Flag Certification

- ◆ **Constraints:** Alteration of **natural hydrological regimes** due to groundwater salinization; **Proliferation of invasive species** like Water hyacinth; **Unsustainable harvesting of wetland resources** such as wood, fish, water, sand etc.

Challenges Associated

- ◆ **Implementation:** States to review their national laws and share information.
- ◆ **Ambiguous Language of the Convention:** Makes obligation to restore wetlands uncertain.
- ◆ **Absence of Formal Dispute Settlement:** Hinders effective implementation.

Way Forward

- ◆ **Mutual Cooperation and Support among States:** Ensuring regional implementation.
- ◆ **Building Societal consensus**
- ◆ **Monitoring:** Environmental Impact Assessment (EIA).

Conclusion

Wetland **provide substantial economic value** through services like **flood protection and water purification**, etc.

5.4. Treaty on Intellectual Property, Genetic Resources and Associated Traditional Knowledge

The treaty has been adopted by the **World Intellectual Property Organization (WIPO)**.

About the Treaty

- ◆ **First WIPO Treaty** to address the interface between Intellectual Property (IP), Genetic Resources (GR) and Traditional Knowledge (TK) and include **provisions for Indigenous Peoples** and local communities.
- ◆ It will establish in international law, a **new disclosure requirement for patent applicants** based on GR and/or associated TK.
- ◆ **Patent applicants must disclose:** Country of origin of GR; Indigenous peoples/local community that provided the associated TK.
- ◆ **Members:** Any **member states** of WIPO **may become party**.
- ◆ **Non-retroactivity:** Not applicable on patents filed prior to entry into force of this treaty.

About Genetic Resources (GRs) and Associated Traditional Knowledge (TK)

- ◆ **GRs** are contained in medicinal plants, agricultural crops, and animal breeds. They are protected using inventions developed through them.
- ◆ **TK** are knowledge system held by indigenous communities.
- ◆ **Importance of TK:** **Natural Resource Managers** (E.g., Karez or surang bavi system); **Scientific research** (E.g., Polyculture technique called Milpa by Mayan people for regenerative agriculture); **Forest conservation** (Sacred Groves conservation by Garo and Khasi tribes in Meghalaya), etc.
- ◆ **Challenges associated:** Biopiracy; Limited Farmers rights; Lack of documentation, etc.

Measures by Government to Protect India's TK and GRs

- ◆ Traditional Knowledge Digital Library (TKDL)
- ◆ **Legislations:** Patent Act, 1970; The Protection of Plant Varieties and Farmer's Rights Act, 2001, etc.
- ◆ **Ministry of AYUSH:** Dedicated ministry for traditional medicine.
- ◆ **UNESCO recognition:** Yoga, etc. recognized as Intangible Cultural Heritage.

Conclusion

The treaty would **curb biopiracy, enhance ethical innovations** making the **IP framework more inclusive**.

5.5. Biological Diversity (Access and Benefit Sharing) Regulation 2025

The National Biodiversity Authority (NBA) has issued the Biological Diversity (Access and Benefit Sharing) Regulation 2025.

Key Highlights of the Rule

- ◆ **Aim:** To regulate the fair sharing of benefits from the use of biological resources and associated knowledge.

- ◆ **Statutory Framework:** Notified by NBA as per **Biodiversity Act (BDA) 2002** replacing 2014 rules.
- ◆ **Key Features:** Inclusion of Digital Sequence Information (DSI), prior informed consent (PIC), profit sharing, transfer of research results, and benefit sharing for IPR commercialisation.

Challenges

- ◆ **Transboundary** nature of resources makes difficult to obtain PIC.
- ◆ **Difficulty distinguishing** between academic and commercial research.
- ◆ **Limited regulation** of customary laws.
- ◆ **Weak institutional capacity**, and monitoring issues.

Way Forward

- ◆ **Multilateral benefit-sharing** across borders.
- ◆ Legally recognize customary laws of **indigenous communities** and integrate them into ABS frameworks.
- ◆ **Clarifying research use** to prevent misuse,
- ◆ **Others: Digitize Documentation** through technological use; improve monitoring, etc

Conclusion

Rules ensure **local researchers** play a central role in any commercially-viable research.



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6. DISASTER MANAGEMENT

6.1. The Disaster Management (Amendment) Act, 2024

Disaster Management (Amendment) Act, 2024 was enacted to amend the **Disaster Management Act 2005**.

Need for Amendment in Disaster Management Act (DMA) 2005

- ◆ **Inadequate Integration of Disaster Risk Reduction (DRR)** E.g. 2013 **Uttarakhand floods** demonstrated inadequate land-use planning, early warning systems, construction regulation.
- ◆ **Fostering effective community participation** as **community members are first responders**.
- ◆ **Weak Project Planning and Execution** of Disaster management activities by **NDMA**.
- ◆ **Insufficient Addressing of Health-Related Issues** like epidemics in previous act.
- ◆ **Addressing Systemic and Cascading** nature of disasters and climate risks.

Key amendments under Disaster Management (Amendment) Act, 2025

- ◆ **NDMA and SDMA** given responsibility to prepare DM plans
- ◆ **New functions added for NDMA and SDMA:** Taking periodic stock of disaster risks, Providing technical assistance to authorities.
- ◆ State governments empowered to constitute a separate **Urban Disaster Management Authority (UDMA)** for state capitals and a **State Disaster Response Force (SDRF)**.
- ◆ **Statutory status** to **National Crisis Management Committee (NCMC)** and the **High Level Committee (HLC)**
- ◆ **Provides for the creation of a disaster database** at the national and state levels.

Potential Issues with Act

- ◆ **Financial constraints** of Urban Local Bodies to effectively set up and run the UDMA.
- ◆ **Excessive rulemaking power to Central government**, through delegated legislation
- ◆ Bill is brought under **Entry 23 of the Concurrent List of Seventh Schedule** which deals with “social security and social insurance, employment and unemployment”.
- ◆ Bill **does not expand the list of notified disasters** to include climate-induced disaster.

Key Provisions of Disaster Management Act 2005

- ◆ **Establishment of Authorities:** Act establishes a three-tier structure for disaster management.
 - ▶ National Disaster Management Authority (NDMA)
 - ▶ State Disaster Management Authorities (SDMAs)
 - ▶ District Disaster Management Authorities (DDMAs)
- ◆ **Preparation of Disaster Management Plans:** At national, state, and district levels.
- ◆ **National Disaster Response Force (NDRF):** for specialized response to disasters.

Conclusion

Act aims to strengthen disaster risk reduction and management by **introducing new structures like Urban Disaster Management Authorities**. However, its success will hinge on overcoming challenges related to coordination, authority, and resource allocation among various levels of government.

6.2. Technology in Disaster Management & Risk Reduction (DMRR)

Recently, advancements in geospatial technology based on AI, Machine Learning (ML) and Internet of things (IoT) have been widely used in DMRR.

Use of Technology in Disaster Management Cycle

- ◆ **Prevention/Mitigation.** E.g., **building hazard maps using AI**.
- ◆ **Preparedness:**
 - ▶ **Disaster prediction and early warning systems:** E.g. Google Disaster Alerts; Odisha SDMA's "SATARK".
 - ▶ **Event simulation:** E.g. Mobile Learning Hub Philippines.

◆ Response:

- ▶ **Emergency communication:** E.g., Covid-19 chatbots launched by WHO.
- ▶ **Search and rescue:** E.g. **Use of drones in Wayanad after landslide** for search and rescue mission.

◆ **Recovery:** Use of drones to transport essential goods.

Conclusion

The **integration of technologies** has significantly **improved the accuracy of early warnings**, efficiency of emergency responses, and effectiveness of post-disaster recovery.

6.3. Earthquake Management in India

Taiwan rocked by earthquake of magnitude 7.4, biggest in 25 years.

About Earthquakes

- ◆ **Sudden, rapid shaking of the earth** caused by the **shifting of underground rock**.
- ◆ **Causes: Tectonic Plate Movements; Fault Slippage** (Build-up of stress along the fault line overcomes the friction between rocks); Volcanic and anthropogenic activities, etc.
- ◆ **Vulnerability In India: 59% of the Indian landmass** classified as earthquake-prone.
- ◆ **Recent Earthquakes:** Myanmar earthquake, Delhi-National Capital Region (NCR) Shallow Earthquake, Taiwan Reverse Faulting etc.

Initiatives

- ◆ **Earthquake Risk Assessment and Mapping** by GSI
- ◆ **Indian Standard Code** for seismic design and construction of structures (IS 1893) by BIS.
- ◆ **Others:** Earthquake Early Warning System (EEWS), National Earthquake Risk Mitigation Project

Way forward (NDMA Guidelines)

- ◆ Ensure **incorporation of Earthquake resistant design features**.
- ◆ **Facilitate selective strengthening and seismic retrofitting** of existing priority structures.
- ◆ **Others:** Improve the compliance regime; capacity development interventions; strengthen emergency response capability, etc.

Conclusion

With over half of India prone to earthquakes, proactive risk assessment, resilient infrastructure, and strict compliance with safety norms are essential for effective disaster preparedness and mitigation.

6.4. Landslide Management

Hilly regions of Wayanad district of Kerala experienced one of the worst landslides in recent history.

About Landslides

- ◆ **Landslide** occurs when **gravity forces on hill slope material exceed the frictional forces** holding the material in place, causing **slope failure**.
- ◆ **India's Landscape Susceptibility to Landslides (Indian Landslide Susceptibility Map (ILSM)):** 13.17% of India's geographical area. India accounts for about **8% of global fatalities** due to landslides.

Causes of Landslides

- ◆ In Himalayas:
 - ▶ **Geological Factors:** Steep slopes, rapid rivers, rockfalls, and intense water saturation.
 - ▶ **Other reasons:** Slope cutting, lack of comprehensive land use policy, Hydropower Projects and excessive tourism.
- ◆ In Western Ghats:
 - ▶ Basalt rocks, high gradient, Deforestation, Mining, Construction activities.
 - ▶ **Western Ghats require less rainfall** to trigger landslides due to greater water retention.

Initiatives

- ◆ National Landslide Susceptibility Mapping (NLSM) Programme
- ◆ **Landslide Atlas of India** by National Remote Sensing Centre of ISRO.

- ◆ GSI recently established National Landslide Forecasting Centre
- ◆ Bhusanket Web Portal and Bhooskhalan Mobile App

Way forward (NDMA Guidelines)

- ◆ No construction in the areas having **slopes above 30 degrees or areas falling on spring lines and first-order streams.**
- ◆ Perform **load-bearing tests**, use of **hazard zonation**, and **slope and land-use maps in urban planning.**
- ◆ Fast-growing **trees and useful grasses to be grown.**
- ◆ Provisions in **MNREGA scheme for structural mitigation of landslides** in hill areas.

Conclusion

Given India's high landslide vulnerability, especially in hilly regions, proactive zoning, resilient infrastructure, and nature-based solutions are vital for minimizing risk and safeguarding communities.

6.5. Cyclone Management in India

IMD has issued red and orange alerts for multiple districts in Kerala and Tamilnadu due to Cyclone Fengal's residual impact.

About Cyclones

- ◆ **Large-scale system of air that rotates around the centre of a low-pressure area** accompanied by **violent storms and bad weather** rotating **anticlockwise** in Northern Hemisphere and **clockwise** in Southern Hemisphere.
- ◆ **India's vulnerability:** Exposed to **nearly 10% of the World's tropical cyclones.**
- ◆ **Recent Occurrences:** Cyclone **Dana** (2024) Along Odisha Coast; Cycone Fengal (2024) , Along Tamil Nadu, Puducherry; Cyclone Remal (2024) over Bay of Bengal.

Management Framework in India

- ◆ **Institutional: National Cyclone Risk Mitigation Project (NCRMP)** by MHA; **Project management and institutional support** at National, State and District level; etc.
- ◆ **Dynamic impact based Color coding warnings:** By IMD like Green (no action), yellow (be watchful), orange (be alert), and Red (take action).

Way forward (NDMA Guidelines)

- ◆ Establishing **state-of-the-art cyclone early warning system (EWS).**
- ◆ **Mapping and delineation of coastal wetlands**, patches of mangroves and shelterbelts.
- ◆ **Exclusive eco-system monitoring network** to study the impact of climate change.
- ◆ Establishing a **comprehensive 'Cyclone Disaster Management Information System' (CDMIS).**

Odisha Model with goal of 'zero-human casualties'

- ◆ Proactive approach (First Indian state to establish a disaster management authority)
- ◆ Cyclone or tsunami warnings through sirens and mass messaging
- ◆ Multi-hazard disaster- resilient houses & Community-Based Disaster Preparedness (CBDP)

Conclusion

With rising cyclone frequency, India must strengthen early warning systems, ecosystem buffers, and community-based preparedness—replicating successful models like Odisha's—to minimize human and economic losses.

6.6. Glacial Lake Outburst Floods (GLOFs)

According to a recent report by Central Water Commission (CWC), glacial lakes and other water bodies in the Himalayas have expanded their surface area.

About Glacial Lake Outburst Flood (GLOF)

- ◆ Sudden release of significant amount of water retained in a glacial irrespective of the cause.
- ◆ **Recent Occurrences:** 2023 (GLOF at South Lhonak, Sikkim), Kedarnath (2013), Chamoli (2021).

Major Causes of GLOFs

- ◆ **Rapid glacier advance.** (E.g., Gilkey Glacier, Alaska)

- ◆ **Moraine dam instability** (E.g., South Lhonak GLOFs, Sikkim), Ice dam failure, Seismic activity
- ◆ **Human Activities** (Unregulated urbanization, irrational mining, deforestation, hydropower projects, GHG emissions etc.)

Way forward (NDMA Guidelines)

- ◆ **Structural and Non-Structural Measures:** Controlled breaching, siphoning, and construction of outlet control structures.
- ◆ **Advancing Monitoring and EWS:** Integration of satellite-based monitoring and Geographic Information Systems (GIS)
- ◆ Focus on the **latest scientific research** and case studies from Himalayas.
- ◆ Facilitate collaboration among **experts, policymakers, and stakeholders.**

Conclusion

The growing threat of GLOFs in the Himalayas demands science-led monitoring, structural safeguards, and coordinated action to prevent large-scale disasters in vulnerable mountain regions.

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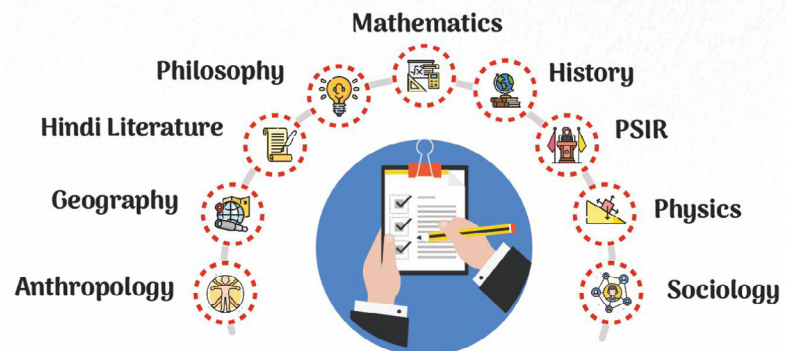
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7. GEOGRAPHY

7.1. El-Nino – Monsoon Link

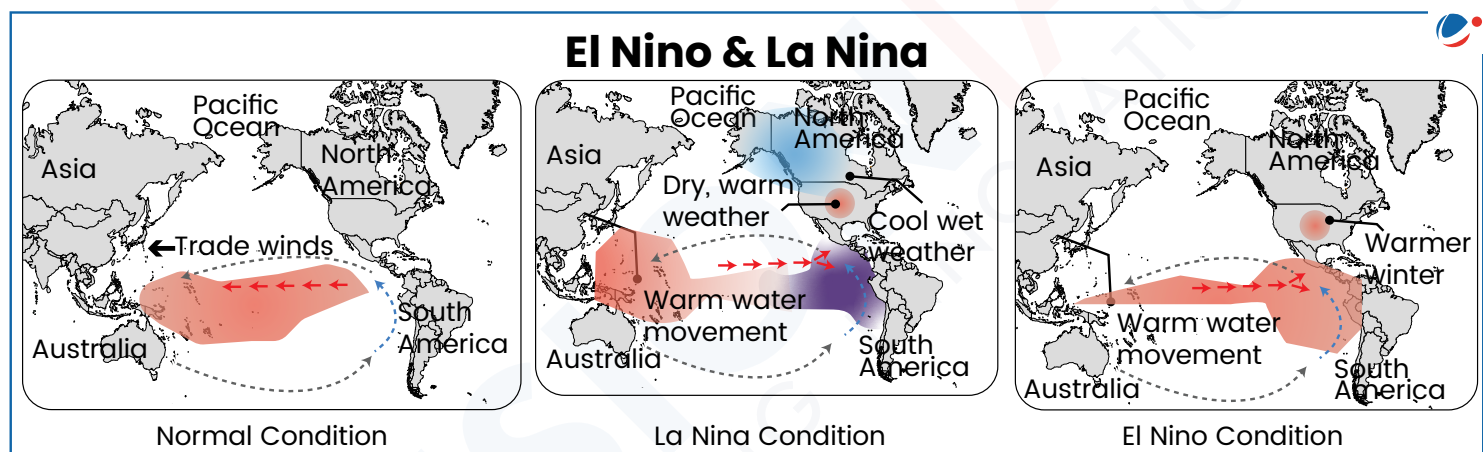
A Study in Nature's Scientific Report reveals **regional and temporal variability** of Indian summer monsoon rainfall in relation to **El Niño Southern Oscillation (ENSO)**.

Major Finding

El-Nino monsoon relationship **diminished in Central India**, became **strong in North India**, and showed **no considerable variation over South India**.

About ENSO

- ◆ **Recurring climate pattern** involving **changes** in the **Central and Eastern tropical Pacific Ocean waters**.
- ◆ **Occurrence: Irregular cycles** of **2-7 years** with **3 phases**, namely, **ENSO neutral, El Nino and La Nina phases**.
- ◆ **Relationship between ENSO and Indian monsoon rainfall:** Inverse, with El Niño suppressing monsoon rainfall and La Niña enhancing it.



How El Nino impacts Monsoon

- ◆ Weakens **walker circulation and Shifts** Jet Stream
- ◆ **Weakens pressure gradient** between Indian Ocean and Pacific Ocean
- ◆ **Leads to atmospheric stability** that **inhibits the vertical movement** of air and suppresses the development of **convective clouds**.

Conclusion

Amidst **rising warming**, it is advisable for researchers to study in detail the **mechanism of ENSO and Indian Monsoon**.

7.2. 150 years of India Meteorological Department (IMD)

Mission Mausam was launched to **mark 150 Years of IMD**.

About Mission Mausam

- ◆ **Ministry:** Ministry of Earth Sciences (MoES).
- ◆ **Aim:** Make India a **"Weather-ready and Climate-smart"** nation.
- ◆ **Phase-I** will be implemented in **2024-26**.
- ◆ **Implementation:** IMD, the Indian Institute of Tropical Meteorology, and the National Centre for Medium-Range Weather Forecasting.

About IMD (Hq: New Delhi [Initially Calcutta])

- ◆ **Establishment:** 1875
- ◆ Provides **meteorological information** for weather-sensitive activities (Agriculture, etc.) and **warns against severe weather phenomena** (Cyclones, etc.).

- ◆ Major achievements
 - ▶ Reliable **weather data collection**.
 - ▶ **Perfected monsoon forecasting** and **boosted telecommunication**.
 - ▶ Accurate cyclone warnings **reducing deaths from 10,000 (1999) to zero (2020–24)**.
 - ▶ Serves as **UN Early Warning for All** advisor to five developing nations.

Conclusion

IMD continues to **evolve, ensuring its services remain relevant and impactful** amidst rising weather unpredictability.

7.3. Bharat Forecast System (BFS)

Bharat Forecast System Launched by **Ministry of Earth Sciences (MoES)**.

Key Features

- ◆ **High-Resolution Forecasting:** BFS provides **6 km resolution forecasts** for tropical regions.
- ◆ **Local Forecasting:** Down to panchayat level.
- ◆ **Accuracy: 30%–64% improvement** in extreme rainfall forecasts using real-time modelling.
- ◆ **Doppler Weather Radar Network:** Utilizes 40 Doppler Weather Radars (DWRs).

About Hyperlocal Weather Forecasting

- ◆ It **pinpoints weather conditions** to extremely **localized areas**.
- ◆ **Significance:** Disaster Preparedness; safeguarding agricultural livelihoods, Global Climate Resilience; Traffic Management in Urban Areas.

Key Challenges

- ◆ Outdated **prediction models**.
- ◆ IMD operates **around 800 automatic weather stations, 1,500 automatic rain gauges** (Total Need: 3, 00, 000) and **37 doppler weather radars** (Needed: 70).
- ◆ **Difficulty in predicting** erratic and dynamic small-scale events.

Key Initiatives for Hyperlocal Weather Forecasting

- ◆ **IFLOWS-Mumbai** by MoES.
- ◆ **CoS-it-FlowS:** For flood forecast In Kerala.
- ◆ **Others:** Gram Panchayat-Level Weather Forecasting, Mission Mausam, etc.

Way Forward

- ◆ **Understanding complexities** of climate change and harness **AI for better prediction**.
- ◆ **Consider local ecology** and **socio-economic conditions**.
- ◆ **Upgradation** of weather forecasting infrastructure.

Conclusion

Significant investments in **technology, research, and infrastructure** is required for effective hyperlocal forecasting.

7.4. River Linking Project

Maharashtra approved **Wainganga-Nalganga River Linking Project** and PM laid foundation of **Ken-Betwa Linking Project**.

About Interlinking of Rivers

- ◆ **National River Linking Project (NRLP)** aims to **connect surplus rivers with deficient ones**.
- ◆ **Background: National Water Development Agency (NWDA)** identified 30 links under the **National Perspective Plan (NPP)** in 1980.
- ◆ **Ken Betwa river link:** Approved in 2021 by the Union Cabinet as 1st river interlinking project)

Benefits of River Interlinking

- ◆ Benefits **35 million hectares for irrigation**.

- ◆ Generation of **around 34000 Megawatt of hydro power.**
- ◆ **Others:** Canal for navigation, employment generation, etc.

Challenges

- ◆ **State water disputes:** Including **bilateral disputes** for transboundary rivers.
- ◆ **Environmental impact:** Proposed Daudhan dam for Ken Betwa Link Project could submerge **10% of tiger habitat in Panna Tiger Reserve**
- ◆ **Social:** Polavaram Link project, part of **Mahanadi-Godavari-Krishna-Pennar-Cauvery-Vaigai Rivers'** interlinking, has **impacted 1 lakh families (80% being Tribal).**

Government Steps

- ◆ **Task Force** for Interlinking of River.
- ◆ **Special Committee** for Interlinking of Rivers (2014)
- ◆ Group on **Intra-state River Links (2015)**
- ◆ **National Bank for Agriculture and Rural Development funding** towards Pradhan Mantri Krishi Sinchayee Yojana.

Conclusion

Integrating **traditional solutions** like **Mangal Turbine** along with **smart technologies** are key for project's success.

Judicial pronouncement in context of Interlinking of Rivers



In Re: Networking of Rivers (2012): SC recognised the need for inter-linking of rivers in India and directed the Central Government to constitute a **Special Committee** for Inter-linking of Rivers which will be responsible for carrying out the inter-linking program.

7.5. Atmospheric Rivers (ARs)

Scientists warn about **intensification of ARs** due to global warming.

About AR or Flying Rivers

- ◆ **Long, narrow air corridors** that transport water vapor from the **tropics to the poles.**
- ◆ Account for **90% of global moisture transfer outside the tropics.**
- ◆ **Embedded in low-level jet streams** within extra tropical cyclones.
- ◆ **Recent examples of Intensification of ARs:** New Zealand (2022), California (2022-23).

Impact on India

- ◆ **Alters monsoon dynamic, ARs linked to 7 of India's 10 worst monsoon floods** (1985–2020), including 2013 Uttarakhand and 2018 Kerala floods.
- ◆ **Increased rainfall accelerates snow melt**, lowering snow albedo and affecting glacier stability.
- ◆ AR-driven water vapor intrusions worsen fog and haze in the Indo-Gangetic Plains.

Impact of Climate Change on ARs

- ◆ Expected to become **50–290% more frequent by 2100** with a **poleward shift.**
- ◆ **Worsen floods** in some regions while depriving others of rainfall.

Consequences of shifting ARs

- ◆ **Subtropics:** Longer droughts and declining water availability
- ◆ **Higher Latitudes:** More extreme precipitation, floods, and faster **sea-ice melting**, especially in the **Arctic.**
- ◆ **Indian Ocean Region:** **Warming seas** and increased **vapour pressure deficit (VPD)** enhance evaporation, fueling AR formation and landfall.

Conclusion

Better **forecasting, and region-specific mitigation strategies** are required to deal with threats posed by ARs.



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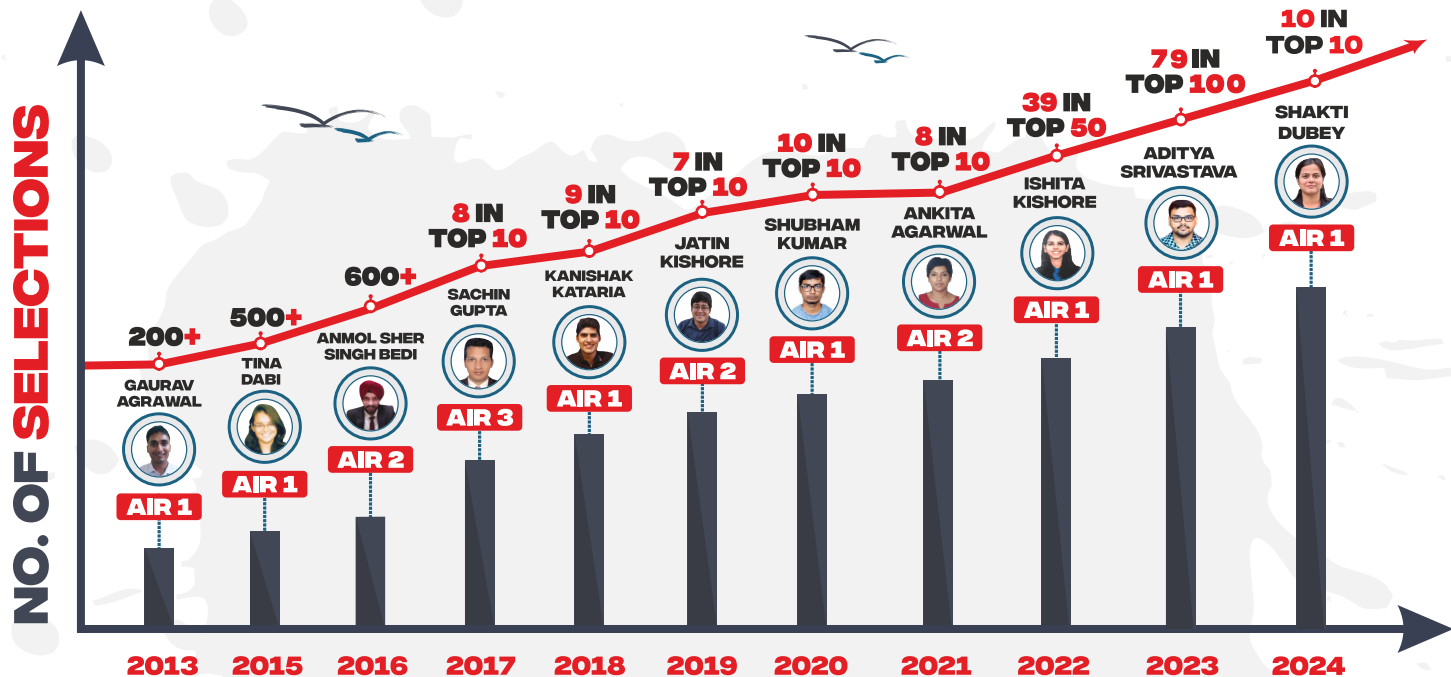


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