Q.1) With cities like Delhi turning into seasonal "gas chambers," urban air pollution in India has become a chronic public health and governance crisis. Discuss. (150 words, 10 marks)

Introduction

According to **WHO (2023)**, **39** of the world's **50** most polluted cities are in India. As per **CPCB**, **131** Indian cities exceed national air quality standards. Urban smog, particularly in Delhi, reflects a chronic governance and public health crisis.

Body

Why Cities Like Delhi Are Turning into "Gas Chambers"

1. **Crop Residue Burning**: Satellite data shows stubble burning in **Punjab** and **Haryana** contributes up to **40%** of Delhi's **PM2.5** levels in winter.
2. **Meteorological Trapping**: Winter temperature inversion and low wind speeds trap pollutants, preventing their dispersion and leading to choking smog.
3. **Vehicular Emissions**: Delhi has over **1.2 crore** registered vehicles—a major source of NOx, PM, and ozone precursors, especially from diesel engines.
4. **Dust and Construction**: Unregulated construction, road dust, and open dumping generate high coarse **PM10** levels year-round, compounding seasonal spikes.

Health Impacts of Urban Air Pollution

1. **Public Health Emergency**: As per the **Lancet (2020)**, air pollution contributed to **1.67 million** deaths in India in **2019** alone.
2. **Respiratory Illnesses**: Surge in asthma, bronchitis, lung cancer, and reduced lung function—especially among children and the elderly.
3. **Cognitive and Maternal Risks**: Studies show links to cognitive decline, low birth weight, and premature deliveries.
4. **Economic Costs**: The **World Bank** estimates air pollution cost India ~**8.5% of GDP** through health burden and lost productivity.

Why It Has Become a Governance Crisis

1. **Fragmented Jurisdiction**: Overlapping responsibilities between Centre, State, ULBs, and pollution control boards lead to policy paralysis.
   Example: **Delhi's Graded Response Action Plan (GRAP)** is often poorly coordinated across NCR.
2. **Seasonal Politicisation**: Air pollution is treated as a winter issue, with blame-shifting over stubble burning, ignoring systemic year-round sources like vehicular and industrial pollution.
3. **Weak Enforcement**: Despite the **Air (Prevention and Control of Pollution) Act, 1981,** compliance is poor. Polluters often go unpunished due to weak regulatory capacity.
4. **Lack of Data Transparency**: Real-time air quality monitoring is patchy. Many cities lack continuous air monitoring stations.
5. **Inadequate Urban Planning**: Dense construction, shrinking green spaces, and high vehicular dependency worsen urban air quality.
   Example: The **IIT Kanpur study** on Delhi's pollution found secondary particles and vehicular exhaust as top contributors.

Steps Taken So Far

1. **Commission for Air Quality Management (CAQM)**: Established in **2020** to coordinate air quality management in the NCR region. However, its impact remains limited by jurisdictional challenges.
2. **Faster Adoption of Clean Fuels**: India leapfrogged to **BS-VI fuel in 2020.** Promotion of EVs through **FAME** schemes is ongoing.
3. **National Clean Air Programme (NCAP)**: Launched in **2019** with a target of **40%** PM reduction in **131 cities by 2026**. However, progress is uneven.
4. **Technological Interventions**: Use of smog towers, bio-decomposer sprays, and **SAFAR** (System of Air Quality and Weather Forecasting and Research) for real-time forecasting and public awareness.

Measures to Address the Crisis Holistically

1. **Legal Accountability**: Make clean air a **legally enforceable** right under the Air Act, with penalties for non-compliance by agencies and polluters.
2. **Air-Shed Management**: Move from city-centric to regional pollution control, with cross-state coordination (especially in **Indo-Gangetic plain**).
3. **Sustainable Urban Mobility**: Invest in mass public transport, cycle lanes, walkability, and disincentives for private car use.
4. **Decentralised Monitoring and Citizen Science**: Promote **community-owned AQI sensors** and real-time pollution data for greater transparency.
5. **Green Urban Design**: Mandate green building codes, vertical gardens, and urban forestry in all **smart city and AMRUT plans**.
6. **Adopt Global Best Practices**: Emulate cities like **London (ULEZ congestion pricing)**, **Beijing (industrial relocation), and Seoul (eco-zone transformation)** to design context-sensitive Indian solutions.

Conclusion

With air pollution costing **~8.5% of India's GDP (World Bank)**, inaction threatens both health and economic stability. Urgent, coordinated, and sustained efforts are essential to secure urban futures and national development.

Q.2) India's biodiversity hotspots are under threat from developmental pressures and invasive species. How does this dual challenge complicate conservation efforts? (150 words, 10 marks)

Introduction

Norman Myers defined biodiversity hotspots as regions rich in endemic species but under threat. India has **four**: Himalayas, Indo-Burma, Western Ghats–Sri Lanka, and Sundaland. These ecologically sensitive areas face mounting anthropogenic and biological stressors.

Body

Developmental Pressures on Biodiversity Hotspots

1. **Infrastructure Expansion**: Linear projects like roads, railways, and hydropower in the Himalayas and Western Ghats fragment habitats.
   Example: **Char Dham highway project** threatens alpine biodiversity and triggers landslides.
2. **Mining and Quarrying**: Unsustainable extraction for limestone, coal, and bauxite disrupts ecosystems.
   Example: Biodiversity loss in **Meghalaya's Indo-Burma hotspot** due to rat-hole mining.
3. **Tourism and Urbanisation**: Ecotourism often turns exploitative, with poorly planned resorts and waste dumping.
   Example: Overtourism in **Munnar** affecting **Nilgiri Tahr** habitats.
4. **Agricultural Encroachment**: Forest-to-farm conversions for tea, coffee, or areca plantations reduce natural forest cover.
   Example: Expansion in Western Ghats causes loss of native tree species (Western Ghats Ecology Expert Panel – **Gadgil Report, 2011**).

Threat from Invasive Alien Species (IAS)

1. **Habitat Displacement**: IAS outcompete native flora and fauna for resources. Example: **Lantana camara** has taken over large tracts of Western Ghats forest understorey
2. **Food Chain Disruption**: Species like **Prosopis juliflora** reduce availability of native fodder.
3. **Ecosystem Function Loss**: IAS can change soil chemistry, hydrology, and fire regimes. Example: **Eichhornia** in wetlands causes eutrophication **(CPCB Report 2020)**
4. **Compounding Climate Stress**: IAS thrive in warmer, disturbed habitats, accelerating spread.

Solutions to Address the Dual Challenge

1. **Ecologically Informed Development**: Apply the **'no-go' principle** in critical habitats and enforce eco-sensitive zone rules.

2. **Invasive Species Control Programs**: Create IAS task forces for mapping, monitoring, and biological control. (Suggested by **National Biodiversity Authority**, **2023**).
3. **Community-Based Conservation**: Empower locals via eco-restoration and **Biodiversity Management Committees** under the **Biological Diversity Act, 2002**.
4. **Strict EIA and Environmental Governance**: Use science-based assessments in hotspot regions. **(T.S.R. Subramanian Committee, 2014)**.
5. **Research and Restoration Ecology**: Support habitat restoration through **CAMPA funds**.

Conclusion

Safeguarding India's biodiversity hotspots is vital to achieving **UNCBD targets** on conservation and restoration. A balanced, science-backed strategy will secure both ecological integrity and long-term sustainable development

Q.3) The rapid melting of Arctic ice is no longer a remote environmental concern. Analyze its cascading effects on global climate patterns and India's environmental security.

Introduction

According to **IPCC AR6 (2023)**, Arctic sea ice has declined by over **40%** since **1979**. This ongoing crisis has far-reaching consequences, disrupting global climate systems and posing direct risks to India's environment and long-term security.

Body

Cascading Effects on Global Climate Patterns

1. **Jet Stream Distortion**: Arctic warming weakens the polar jet stream, leading to extreme weather shifts across continents.

   Example: **2021 Texas cold wave**, **2022 European heatwave** – **WMO** reports.
2. **Acceleration of Warming**: Melting ice reduces the Earth's albedo, amplifying global heat absorption and feedback loops.

   (**NASA, 2021**: Arctic reflects **80%** less sunlight than before)

3. **Disruption of Ocean Currents**: Meltwater may slow the Atlantic Meridional Overturning Circulation (AMOC), altering global rainfall and temperatures.
   (IPCC, 2019: Disruption is threat to thermohaline balance)
4. **Methane Emissions from Permafrost**: Thawing tundra is releasing methane, a potent greenhouse gas accelerating global warming.
   (UNEP, 2020: Tundra stores 1,500 billion tons of carbon)

Implications for India's Environmental Security

1. **Monsoon Disruptions**: Arctic-induced circulation changes impact the strength and timing of Indian monsoons.
   Example: **2022 monsoon** onset delays and uneven rainfall **(IITM, Pune)**.
2. **Coastal Threats from Sea-Level Rise**: Rising seas endanger low-lying regions and ecosystems like the **Sundarbans**.
   Example: Frequent saline ingress in coastal **West Bengal (CWC, 2021)**.
3. **Glacial Retreat in Himalayas**: Teleconnections from Arctic shifts destabilize Himalayan cryosphere.
   Example: Rapid melt in **Gangotri and Zemu** glaciers.
4. **Increase in Extreme Events**: Warmer oceans increase frequency and intensity of cyclones, floods, and heatwaves.
   Example: **Cyclone Amphan (2020)** intensified by elevated Bay of Bengal SSTs **(IMD)**.

Steps Taken So Far

1. **Observer Status in Arctic Council**: India has been an observer since **2013**, enhancing diplomatic and research presence.
2. **National Arctic Policy (2022)**: Lays out vision for scientific research, climate impact study, and strategic engagement.
3. **Himadri Research Station**: India's permanent base in **Svalbard, Norway**, conducts vital polar climate research.

4. **International Collaborations**: Working with **WMO, IPCC, SAON** for Arctic data integration and climate modelling.

Recommendations

1. **Strengthen Arctic Research Capacity**: Expand NCPOR funding, launch indigenous polar expeditions, and link findings to domestic climate models.
2. **Integrate Arctic Signals in National Plans**: Ensure Arctic impacts are reflected in SAPCCs, coastal regulations, and disaster planning.
3. **Enhance Coastal Resilience**: Invest in climate-resilient infrastructure, early warning systems, and mangrove restoration.
4. **Public Education and Policy Awareness**: Introduce polar climate modules in higher education and government training programs.
5. **Adopt Global Best Practices**: Learn from **Norway's Arctic preparedness planning** and **Canada's Indigenous-led environmental monitoring**.

Conclusion

Arctic ice loss contributes to unpredictable weather, rising seas, and glacier retreat, threatening India's environmental security. Urgent response to this **cryosphere crisis** is essential to align with **UNFCCC** goals and protect our ecological and economic future.

Q.4) Wetlands serve as ecological sentinels, yet they remain among the most threatened ecosystems in India. Examine the socio-economic and ecological importance of wetlands, and critically assess the gaps in policy and enforcement that hinder their protection. (250 words, 15 marks)

Introduction

According to the Ramsar Convention, wetlands are areas of marsh, fen, peatland, or water that support biodiversity and regulate water regimes. As of **2025**, India has **89 Ramsar sites** covering over **1.33 million hectares** yet faces alarming degradation.

Body

Why Wetlands Remain the Most Threatened Ecosystems

1. **Rapid Urbanization and Land Conversion:** India lost over **30%** of its natural wetlands between **1970 and 2014** due to infrastructure and real estate expansion **(ISRO)**.
2. **Pollution and Waste Dumping: 75%** of urban and peri-urban wetlands are contaminated by sewage, plastic, and industrial effluents **(CPCB, 2021)**.
3. **Climate Change Vulnerability:** Rising temperatures and erratic rainfall are shrinking wetland water levels and disrupting seasonal cycles.

Ecological and Socio-Economic Importance of Wetlands

1. **Biodiversity Hotspots:** Wetlands provide habitats for migratory birds and rare aquatic species. **Keoladeo** and **Chilika** support over **100 bird species**.
2. **Natural Purifiers and Recharge Zones:** Wetlands filter pollutants and recharge aquifers. **East Kolkata Wetlands** save around **Rs 500 million** annually.
3. **Flood Control and Climate Buffer:** Wetlands reduce flood impacts and sequester carbon. **Sunderbans** alone store **~4.15 billion tons of CO_2**.
4. **Livelihood and Food Security:** They support fishing, grazing, agriculture, and tourism. **Loktak Lake** sustains about **1 lakh fishers** in **Manipur.**
5. **Cultural and Religious Significance:** Many wetlands like **Pushkar Lake and Loktak** are deeply rooted in local traditions and religious practices.
6. **Research and Education Value:** Wetlands serve as open laboratories for ecological research, environmental awareness, and student field learning.

Policy and Enforcement Gaps Hindering Protection

1. **Fragmented Governance Framework:** Multiple ministries overlap, causing inaction. The **Ritesh Kumar Committee** recommended a unified wetland authority for coordinated efforts.
2. **Ineffective Wetlands Rules 2017:** Rules exclude man-made wetlands and lack enforcement. Only **13 states** have notified authorities **(CAG 2020)**.

3. **Encroachments from Urban Expansion:** Wetlands are drained for infrastructure. **Bengaluru lost 40%** of its wetlands since **1973.**
4. **Inadequate Monitoring Systems:** Less than **5% of wetlands** are geo-tagged. NWCP lacks updated inventories and real-time tracking.

Recommendations

1. **Enforce Wetlands Rules Effectively:** Ensure all states form and empower State Wetland Authorities with technical capacity.
2. **Technology-Driven Monitoring:** Use **ISRO's Bhuvan and AI tools** for satellite-based tracking and timely alerts.
3. **Community-Led Conservation Models:** Adopt co-management practices like **Chilika Development Authority** involving local stakeholders.
4. **Integrate in Urban Planning:** Include wetlands in master plans and climate infrastructure projects to ensure ecological buffers.
5. **Leverage Existing Schemes and Best Practices:** Integrate wetlands restoration with programs like the **Amrit Dharodhar Scheme** to rejuvenate water bodies and adopt global models like **USA's Clean Water Act** and **Australia's Ramsar zoning**.

Conclusion

Wetlands play a vital role in water security and climate resilience. Protecting them strengthens India's path toward **CBD and Ramsar targets** while safeguarding GDP-linked ecosystem services worth billions annually.

Q.5) The Environmental Impact Assessment (EIA) process in India is often seen as weak and ineffective. In the context of recent clearances for large projects, examine the key problems in the EIA system. What reforms are needed to make it more transparent, participatory, and environmentally sound? (250 words, 15 marks)

Introduction

Environmental Impact Assessment (EIA), notified under the **Environment (Protection) Act, 1986**, is a crucial tool to evaluate environmental consequences of development projects. Yet, implementation challenges have made it ineffective in safeguarding ecological interests.

Body

EIA Process in India

1. **Screening:** Determines if a project requires EIA based on type, scale, and location.
2. **Scoping:** Sets Terms of Reference for the EIA report.
3. **Impact Assessment & Mitigation:** Identifies likely impacts and mitigation measures.
4. **Public Consultation:** Involves local stakeholders through hearings and written responses.
5. **Appraisal & Decision-making:** Expert Appraisal Committees review the report and recommend clearance or rejection.
6. **Monitoring:** Project implementation is monitored for compliance with environmental conditions.

Recent Concerns

- **Dilutions and Clearances: Draft EIA 2020** included post-facto approvals and reduced hearing windows; projects like **Dibang Dam** and **Great Nicobar** were cleared despite environmental risks.

Key Problems in the EIA System

1. **Conflict of Interest:** Project proponents select consultants, reducing objectivity; **CAG** highlighted this in **2016**.
2. **Token Public Hearings:** Poorly advertised and inaccessible; the **2014 Subramanian Committee** noted this procedural weakness.
3. **Poor Quality Reports:** Reports like **Vedanta's Niyamgiri** case have contained falsified or outdated data.
4. **Weak Monitoring & Compliance: CAG** found only **6%** of cleared projects had compliance checks.
5. **Routine Exemptions: Draft EIA 2020** institutionalised exemptions for linear and strategic projects, weakening environmental oversight.

Reforms Needed

1. **Independent Accreditation:** Set up an **autonomous body** to accredit and audit EIA consultants.
2. **Digitised Transparency:** Use **PARIVESH portal** to publish all EIA documents in regional languages.
3. **Strengthen Public Consultation:** Expand outreach, extend consultation windows, and improve access.
4. **Post-clearance Accountability:** Implement mandatory compliance audits and enforce penalties.
5. **Judicial Reinforcement of Safeguards:** In ***Noble M. Paikada v. Union of India*** **(2024),** the Supreme Court upheld the need for rigorous environmental review by striking down blanket exemptions for linear projects.

Conclusion

Reforming the EIA process is crucial to align development with environmental sustainability. A robust EIA system contributes directly to achieving **SDG Goals 13 (Climate Action), 15 (Life on Land), and 16 (Institutional Justice)**.