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UPSC MAINS PYQs ANALYSIS (2025-2013): ENVIRONMENT

LEVEL 1– GS3 Environmental Pollution and Mitigation



S.NO.	QUESTION	YEAR	SUBJECT	TOPIC	THEME
1	Mineral resources are fundamental to the country's economy and these are exploited by mining. Why is mining considered an environmental hazard? Explain the remedial measures required to reduce the environmental hazard due to mining. (Answer in 250 words) 15	2025	Environment & Ecology	Natural Resources	Mining & Environmental Hazards
2	Industrial pollution of river water is a significant environmental issue in India. Discuss the various mitigation measures to deal with this problem and also the government's initiatives in this regard. (Answer in 150 words)	2024	Environment and Ecology	Pollution and Conservation	Industrial River Pollution and Mitigation Measures
3	What is oil pollution? What are its impacts on the marine ecosystem? In what way is pollution particularly harmful for a country like India? (150 words)	2023	Environment & Ecology	Environmental Pollution and Degradation	Oil Pollution and Marine Ecosystem

LEVEL 2– GS3 Environmental Pollution and Mitigation

S.NO.	QUESTION	YEAR	THEME
166	Mineral resources are fundamental to the country's economy and these are exploited by mining. Why is mining considered an environmental hazard? Explain the remedial measures required to reduce the environmental hazard due to mining. (Answer in 250 words) 15	2025	Mining & Environmental Hazards

Contextual Insight

Mining provides critical raw materials for infrastructure, energy, and industry, yet it is one of the most environmentally damaging activities. It leads to deforestation, air and water pollution, land degradation, biodiversity loss, and displacement of communities. For India, which is resource-rich but ecologically sensitive, unchecked mining threatens sustainability, intergenerational equity, and climate resilience.

The regulatory framework evolved through constitutional provisions like Article 48A (environmental protection), Article 51A(g) (fundamental duty), and Article 21 (right to clean environment). Laws such as the Environment Protection Act (1986), Forest Conservation Act (1980), and Mines and Minerals (Development & Regulation) Act (MMDR, 1957, amended 2015) regulate mining activities. Judicial interventions such as the *Samata Judgment* (1997) and *Goa Foundation cases* linked mining with tribal rights and ecological limits. Recent measures like District Mineral Foundation (2015), Sustainable Development Framework for Mining (2016), and ESG-linked reforms (2021–24) highlight the transition towards balancing mineral extraction with ecological and social safeguards.

Answer Enrichment

- **Constitutional Mandate → Article 48A & 51A(g)**

These provisions obligate the state and citizens to protect the environment.

Mining-induced deforestation in Odisha and Jharkhand has highlighted the need for strict enforcement of these duties.

- **Judicial Oversight → Supreme Court in Samata Judgment (1997)**

Recognized the rights of tribal communities over forest resources. In recent years, courts have suspended illegal mining in Goa and Karnataka due to severe ecological damages.

- **Pollution Control → Environment Protection Act (1986)**

Provides powers to regulate air, water, and soil pollution from mining. Implementation remains uneven, especially in small-scale mines.

- **Mine Closure Guidelines → Sustainable Development Framework (2016)**

Mandates scientific mine closure and reclamation. Pilot projects in coal mines of Chhattisgarh show land restoration potential but funding gaps persist.

- **Community Benefit → District Mineral Foundation (2015)**

Mining revenues are earmarked for local development and health. However, audits (2022–23) flagged under-utilization of DMF funds.

- **Climate Action → National Mineral Policy (2019)**

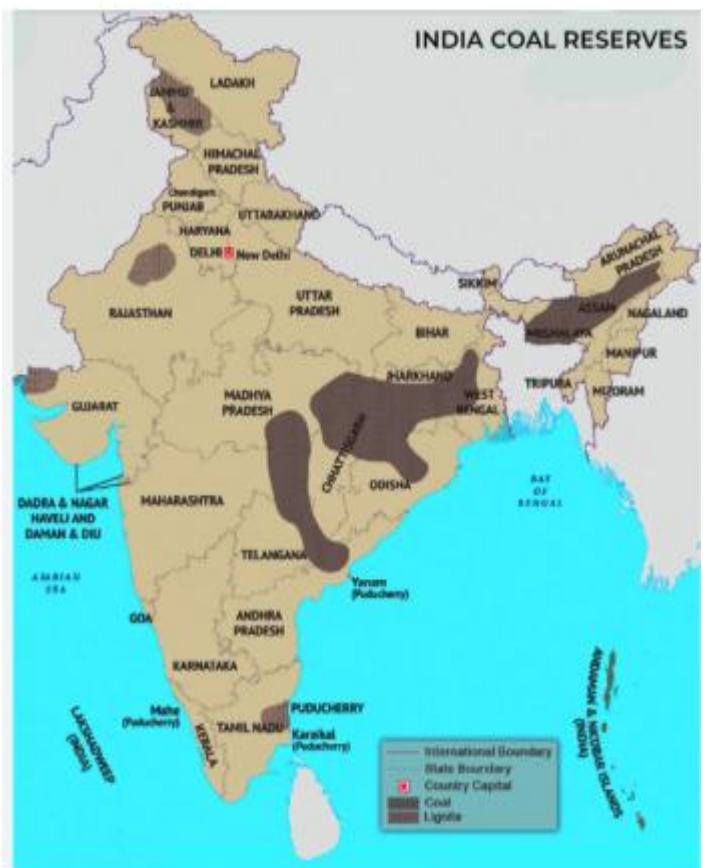
Stresses zero-waste mining and climate-sensitive practices. Yet illegal mining and over-extraction undermine its goals.

- **Global Linkage → Paris Agreement Commitments (2015 onward)**

Mining-sector decarbonization aligns with India's net-zero 2070 pledge. But transition requires clean energy adoption in extractive industries.

Technological Solutions → Drone & IoT Monitoring (2021–24)

Remote sensing and AI-based monitoring detect illegal mining and pollution hotspots, improving accountability and transparency.



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Industrial pollution of river water is a significant environmental issue in India. Discuss the various mitigation measures to deal with this problem and also the government's initiatives in this regard. (Answer in 150 words)

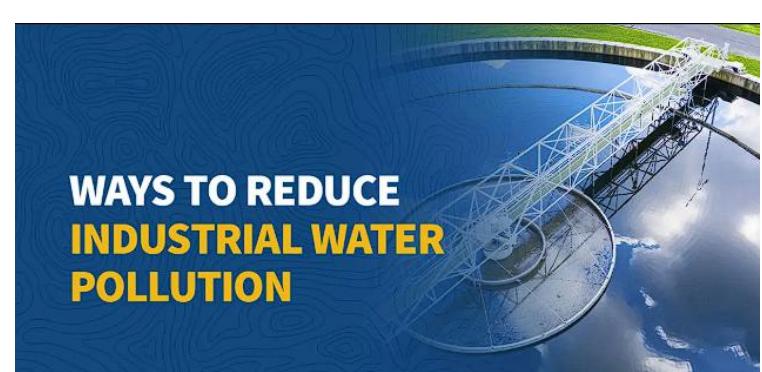
2024

Industrial River Pollution and Mitigation Measures

Contextual Insight

Industrial pollution of rivers stems from untreated effluents containing heavy metals, toxins, and organic waste discharged into water bodies. This challenge undermines India's ecological security and clean water availability, impacting agriculture, fisheries, and public health. It reflects a failure in regulatory enforcement, polluter accountability, and adoption of cleaner production methods.

India's response includes constitutional directives like Article 48A and judicial interpretation of Article 21. The National Green Tribunal, CPCB directives, and the Water Act (1974) provide the legal framework. Recent steps include river-specific action plans (e.g., Namami Gange), stricter consent protocols by Pollution Control Boards, and ETP mandates under Environmental (Protection) Rules. The issue remains critical in the 2021–2024 period due to climate-induced flow variability and rising industrial footprints.



Answer Enrichment

- **Legal Mandate → Water (Prevention and Control of Pollution) Act (1974)**
Empowered Pollution Control Boards to regulate and penalize effluent discharge.
Draws strength from Article 48A; NGT rulings have invoked it in 2022 for polluting paper mills in UP.
- **Judicial Oversight → M.C. Mehta v. Union of India (Ganga Pollution Case, 1987–2023)**
Landmark case establishing the “Polluter Pays” principle.
Reaffirmed in 2023 by NGT against distilleries violating ETP norms along Ganga tributaries.
- **Monitoring Mechanism → CPCB Real-Time Water Quality Monitoring (2023)**
Installed sensors in 351 industrial clusters.
Improves transparency and compliance; aligns with SDG-6 and UNEP water quality monitoring principles.
- **Effluent Treatment → Zero Liquid Discharge Mandates (2021 onward)**
Mandated ZLD for highly polluting industries like tanneries, textiles.
Tamil Nadu’s SIPCOT success inspired similar models in Gujarat and Punjab.
- **River Rejuvenation → Namami Gange Programme Phase-II (2023)**
Shifted focus to industrial clusters in Kanpur, Patna.
Upgraded CETPs; Article 21 used to justify Right to Clean Water.
- **Pollution Control Authority → NGT Oversight Committees (2022)**
State-wise implementation tracking through NGT-monitored committees.
Addressed failure of SPCBs to implement Common Effluent Treatment Plants (CETPs).
- **Financial Incentives → AMRUT 2.0 and ETP Upgradation Funds (2023)**
Provided viability gap funding for ETPs.
Encourages compliance among MSMEs; linked to Atmanirbhar Bharat mission for sustainable growth.
- **Technological Innovation → IoT-Based Smart ETPs (2022)**
Piloted in Maharashtra’s MIDC clusters.
Improved pollutant load tracking and compliance automation; aligns with Paris Agreement’s tech transfer goals.

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What is oil pollution? What are its impacts on the marine ecosystem? In what way is pollution particularly harmful for a country like India? (150 words)

2023

Oil Pollution and Marine Ecosystem

Contextual Insight

Oil pollution occurs due to spills from ships, offshore drilling, or coastal refineries, contaminating marine waters with hydrocarbons. It affects marine biodiversity, fisheries, and coastal livelihoods. The question emphasizes India’s ecological and economic vulnerability due to its long coastline, dependence on maritime trade, and fisheries-based coastal economies.

India has responded through MARPOL adherence, National Oil Spill Disaster Contingency Plan (NOS-DCP), and Coast Guard coordination. Events like the MV Devon ship oil spill (2023) show recurring threats. Article 48A and Article 21 have enabled judicial activism, while recent Blue Economy policies push for sustainable marine governance. The issue reflects India’s developmental-environmental trade-off in a climate-sensitive era.



Answer Enrichment

- **International Treaty → MARPOL Convention Compliance (Annex-I, 2021)**
India mandated oil discharge norms in Exclusive Economic Zone.
Aligned with UNCLOS obligations; enforced after 2022 Mumbai offshore leak.
- **Crisis Response → NOS-DCP under Indian Coast Guard (2023 Update)**
Preparedness plan for spill response using skimmers, dispersants.
Activated during Ennore Port spill; linked to SDG-14 (Life Below Water).
- **Judicial Direction → SC on Coastal Regulation Zone (CRZ, 2022)**
Prohibited oil-based industries near fragile ecosystems.
Used CRZ notifications to penalize violators near Sundarbans coast.
- **Economic Risk → MV Devon Spill Incident, Mangalore (2023)**
Disrupted fishing and tourism for weeks.
Highlighted India’s coastal vulnerability and prompted Centre-State disaster synergy.
- **Marine Biodiversity Impact → Coral and Plankton Decline (2021–2023)**
Oil hampers photosynthesis and oxygen diffusion.
Reported coral bleaching in Lakshadweep and Andaman ecosystems post minor leaks.
- **Fisheries Livelihood → Impact in Kerala & Tamil Nadu (2022)**
Oil residues destroy breeding grounds.
Fisherfolk faced economic losses; pushed for compensation under Disaster Relief norms.

- **Surveillance Tech → Satellite and Aerial Monitoring (ISRO & DGCL, 2023)**
Enabled oil leak tracking near shipping lanes.
Strengthened early response; supports LiFE Mission's ecosystem preservation.
- **Policy Push → Blue Economy Policy Draft (2021)**
Proposes marine environmental safeguards.
Encourages sustainable resource use; guided by UNCLOS and Paris Agreement targets.

LEVEL 3– GS3 ENVIRONMENTAL POLLUTION AND MITIGATION

◆ MODEL INTRODUCTION

Environmental degradation, particularly pollution, poses one of the gravest threats to India's ecological security, public health, and developmental sustainability. With rapid urbanization, industrial expansion, and resource over-extraction, pollution is no longer a localized issue but a national crisis affecting rivers, air, soil, and biodiversity systems.

Among these, pollution control — including air, water, and hazardous waste management — emerges as a critical theme in India's pursuit of sustainable development. Issues like industrial effluents, oil spills, photochemical smog, and solid waste accumulation demand integrated strategies backed by science, regulation, and public participation.

Anchored in Article 48A and Article 51A(g) of the Constitution, and supported by key frameworks such as the Environment Protection Act 1986, NCAP, and CAMPA, India is also aligning with its global commitments under the Paris Agreement, SDGs, and UNEP protocols. However, challenges like weak enforcement, ecological injustice, and fragmented institutions continue to impede progress.

Ultimately, India's environmental vision must transcend reactive mitigation and embrace systemic transformation — towards clean air, safe water, and circular economies that are equitable, inclusive, and ecologically sustainable.

● THEMATIC ANALYSIS

Mineral resources are fundamental to the country's economy and these are exploited by mining. Why is mining considered an environmental hazard?

Explain the remedial measures required to reduce the environmental hazard due to mining.

(2025, Environment & Ecology — Natural Resources, Mining & Environmental Hazards)

Directive: Explain — Analyze why mining is hazardous and suggest remedies.

- **Ecological Backdrop:** India is rich in coal, iron ore, bauxite, and other minerals, but intensive mining has degraded forests, rivers, and fragile ecosystems.
- **Deforestation & Habitat Loss:** Large-scale open-cast mining causes deforestation, habitat fragmentation, and endangers species like elephants and tigers.
- **Land Degradation:** Overburden dumps, soil erosion, and altered topography reduce agricultural productivity and disrupt livelihoods.
- **Air & Water Pollution:** Dust emissions, acid mine drainage, and heavy metal leaching contaminate air, rivers, and groundwater.
- **Human Health Impact:** Toxic exposure in mining belts like Jharkhand and Odisha leads to silicosis, respiratory diseases, and waterborne illnesses.
- **Policy & Legal Measures:** Environment Protection Act 1986, Forest Conservation Act, and EIA Notification 2006 regulate mining activity.
- **Technological Remedies:** Adoption of eco-friendly mining, dust suppression, wastewater treatment, and mine closure plans mitigate impacts.
- **Rehabilitation Measures:** CAMPA funds, afforestation drives, and eco-restoration of abandoned mines aid ecosystem recovery.
- **Community & Institutional Role:** District Mineral Foundation (DMF) funds and NGT rulings empower local governance and accountability.
- **Global Best Practices:** Sustainable mining frameworks and ESG-linked investments guide India towards responsible resource use.

1. 2024 | Industrial River Pollution and Mitigation Measures

Directive: Discuss

- Industrial river pollution in India is primarily caused by untreated effluents, heavy metals, and thermal discharges.
- CPCB data shows over 351 polluted river stretches (2023), majorly due to textile, tannery, and chemical units.
- Mitigation strategies include Zero Liquid Discharge (ZLD), Common Effluent Treatment Plants (CETPs), and eco-restoration.
- Legal tools: Water (Prevention and Control of Pollution) Act, 1974 and Environment Protection Act, 1986.
- Programs like Namami Gange integrate pollution abatement with ecological rejuvenation.

- Industrial norms under Ganga Action Plan and stringent discharge standards under EPA 1986 guide compliance.
- River Health Index (NMCG, 2023) and online monitoring (OCEMS) help track pollution sources.
- Bio-remediation, phytoremediation, and constructed wetlands offer eco-friendly treatment alternatives.
- Institutional bodies like CPCB, SPCBs, and NGT drive accountability.
- Moving forward, a polluter-pays principle and real-time industrial audits are vital for sustainable river ecosystems.

2. 2023 | Oil Pollution and Marine Ecosystem

Directive: Discuss

- Oil pollution refers to the release of petroleum into oceans, typically from tankers, offshore rigs, or bilge discharges.
- Impacts: smothering of marine fauna, bioaccumulation in fish, coral reef damage, and coastal ecosystem degradation.
- India, with over 7500 km of coastline and fragile ecosystems (e.g., Gulf of Mannar), faces serious risks.
- 2022 Ennore spill in Tamil Nadu disrupted livelihoods of over 20,000 fisherfolk.
- Institutions: Indian Coast Guard, MoEFCC, and National Oil Spill Disaster Contingency Plan (NOSDCP).
- Pollution is worsened by lack of double-hull standards and inadequate ballast water treatment.
- India needs stricter compliance with MARPOL 73/78 and better satellite surveillance for maritime zones.
- Ports like Mumbai and Chennai require oil spill contingency drills and better response kits.
- Community engagement in coastal cleanup drives and mangrove restoration enhances resilience.
- Transitioning to green shipping and LNG fuels aligns with India's Blue Economy goals.

MODEL CONCLUSION

Environmental protection is not merely a policy choice but a constitutional and civilizational imperative. India's future lies in harmonizing development with sustainability — through low-carbon growth, resilient ecosystems, and decentralized environmental governance. Strengthening science-policy interfaces, enabling grassroots stewardship, and ensuring stringent enforcement will be crucial. A green India must emerge not just as a global environmental leader but as a just and inclusive ecological civilization.

LEVEL 4— GS3 ENVIRONMENTAL POLLUTION AND MITIGATION

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A. Evolution of Question Complexity

- **From descriptive to analytical/application-based:**
 - 2013 (*National Water Policy & hazardous waste laws*): Primarily descriptive, focusing on policy enumeration + river pollution example.
 - 2018 (*Solid waste & Sikkim organic state*): Application-based, linking waste management with ecological/economic sustainability.
 - 2020–21 (*NCAP, WHO AQGs*): Evaluative, testing policy depth, gaps, and reform needs.
 - 2022–23 (*Photochemical smog, oil pollution*): Conceptual + applied, testing causes, impacts, and international protocols.
 - 2024–25 (*River pollution mitigation, mining hazards*): Problem-solving orientation, asking for multi-dimensional remedial measures and policy strategies.
- **From one-dimensional to multidimensional framing:**
 - *Early years (2013)*: Single focus on water policy and hazardous waste.
 - *2018 onward*: Multi-lens questions—waste disposal + sustainable farming; air pollution + global guidelines; river pollution + industrial regulation; mining + ecological rehabilitation.
 - *Now (2025)*: Integrates economy, ecology, governance, and sustainability in one frame.
- **From fact-based to reform/problem-solving orientation:**
 - 2013–2018: Policy description and basic ecological-economic benefits.
 - 2019–2021: Emphasis on institutional measures (NCAP, WHO AQGs) with critical evaluation.
 - 2022–25: Solutions-driven, testing ability to propose actionable reforms across air, water, soil, and resource sectors.
- **Increasing conceptual depth and contemporary relevance:**
 - UPSC moved from static environmental policy questions → applied pollution case studies → international standards → reform-oriented, sustainability-driven frameworks.
 - Reflects rising climate–development discourse (Paris Agreement, COP outcomes, SDGs).

B. Content Evolution Insight

- **Phase I – Policy & Legal Foundation (2013):**
 - National Water Policy + legal provisions on hazardous waste.
 - Early linkage: *policy frameworks* → *environmental management*.
- **Phase II – Waste & Sustainability (2018):**
 - Solid waste disposal + toxic waste; organic farming as sustainable alternative.
 - Introduced *circular economy, sustainable farming models*.
- **Phase III – National Policy Programmes (2020–21):**
 - 2020: NCAP features → national response to air pollution.
 - 2021: WHO AQGs vs NCAP targets → global–domestic policy mismatch.
 - Shift toward *policy evaluation & reform gaps*.
- **Phase IV – Conceptual + International Dimension (2022–23):**
 - 2022: Photochemical smog + Gothenburg Protocol (air–climate link).
 - 2023: Oil pollution impacts on marine ecosystems (India's vulnerability as maritime nation).
- **Phase V – Problem-Solving & Resource Focus (2024–25):**
 - 2024: River water pollution—mitigation strategies + govt initiatives.
 - 2025: Mining as environmental hazard—causes + remedial measures.
 - Strong solution-oriented framing, linking environment with *resource economy & livelihoods*.
- **Trajectory of substance:**
 - “*What are the laws/policies?*” (2013)
 - “*What are the problems & eco-benefits?*” (2018)
 - “*What are India's programmes & reforms needed?*” (2020–21)
 - “*What are the causes, impacts & global linkages?*” (2022–23)
 - “*What remedial measures are required for sustainable balance?*” (2024–25)
- **Anchoring with contemporary debates:**
 - 2013: Ganga Action Plan, Hazardous Waste Rules.
 - 2018: Solid Waste Rules 2016, Sikkim organic model.
 - 2020–21: NCAP (2019), WHO 2021 Air Quality Guidelines.
 - 2022: Gothenburg Protocol on transboundary air pollution.
 - 2023: Oil spills (Mumbai coast incidents, Mauritius Wakashio spill).
 - 2024: NGT orders on industrial river effluents, Namami Gange progress.

- 2025: Mining–environment conflicts (Goa iron ore ban, Odisha bauxite, coal sector reforms).

C. Suggested Approach for Answer Writing & Preparation

- **Mindset expected:**
 - Treat pollution and mitigation as *ecological, developmental, and governance challenges*.
 - Answers should reflect a balance of *scientific understanding + policy frameworks + socio-economic solutions*.
- **Answer writing structure:**
 - **Introduction:** Start with alarming fact/data (e.g., India hosts 14 of world's 20 most polluted cities; NITI Aayog says 70% of water is contaminated).
 - **Body:**
 - Define/explain issue (mining hazard, oil pollution, smog, etc.).
 - Causes/factors (industrialization, urbanization, weak enforcement, climate shifts).
 - Impacts (health, biodiversity, livelihoods, economy).
 - Govt measures/programmes (NCAP, Jal Shakti Abhiyan, Solid Waste Rules 2016, Namami Gange, Environment Protection Act).
 - Reforms/way forward (tech adoption, stricter enforcement, community participation, green mining codes, circular economy).
 - **Conclusion:** Link to SDGs (6, 11, 12, 13, 15), climate resilience, intergenerational equity.
- **Preparation essentials:**
 - Programmes: NCAP, Namami Gange, Atal Bhujal Yojana, Solid Waste Rules, Fly Ash Utilization Policy.
 - Reports: CPCB pollution data, UNEP Emissions Gap, IPCC AR6.
 - Case studies: Delhi smog, Chennai river pollution, Goa mining ban, Sikkim organic farming.
 - International frameworks: WHO AQGs, Paris Agreement, Gothenburg Protocol.
- **Frameworks to embed:**
 - **Air Pollution Lens** → NCAP, WHO guidelines, smog protocols.
 - **Water Pollution Lens** → industrial effluents, river cleaning, hazardous waste disposal.
 - **Soil/Mining Lens** → ecological rehabilitation, sustainable mining.
 - **Waste Management Lens** → solid + toxic waste, circular economy.

Policy Lens → national programmes, global treaties.

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